DOCUMENT RESUME

ED 340 342 IR 015 320

TITLE	Impact Assessment and Forecasts of Information and Telecommunications Technologies Applied to Education and Training: Volume II--Main Report and Issues Analyses. Analysis for the Orientation of the Work of Sector Actors in the Framework of DELTA.
INSTITUTION	Commission of the European Communities, Brussels (Belgium).
REPORT NO	XIII/F/DE1715B
PUB DATE	May 90
NOTE	189p.; Cover title is: "Impact Assessment & Forecasts of Information and Communications Technologies Applied to Flexible and Distance Learning." For related reports, see IR 015 316-323.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC08 Plus Postage.
DESCRIPTORS	Change Strategies; Computer Networks; Computer Software; *Distance Education; *Educational Planning; *Educational Technology; Foreign Countries; Higher Education; Information Technology; Instructional Design; *Marketing; Policy Formation; Political Issues; Postsecondary Education; Program Implementation; Socioeconomic Influences; Supply and Demand; *Telecommunications; *Training Methods
IDENTIFIERS	*Electronic Universities; European Communities Commission

ABSTRACT

This report, the second volume in a three volume set, summarizes the results of a study performed by the DELTA (Developing European Learning through Technological Advance) unit in parallel with the projects underway in the research and development Exploratory Action. The report identifies the key issues, associated requirements and options, and potential actions to be taken. Following an introductory discussion of learning technologies, chapters include the following: (1) Socio-Political and Economic Implications; (2) Potential Market Demand and Problems of Supply; (3) Learning Technology Pedagogics, including educational strategies of advanced learning technologies, support of the learning process, managing the learning process, didactic strategies, human tutoring, intelligent tutoring, explorative and simulated scenarios, and collaborative learning, psychological and motivational factors, demonstrating learning technology effectiveness, evaluating costs of learning technologies, evaluating processes and skills, evaluating resources, and design methodologies; (4) Learning Technology, including systems standards, learning configurations, learning facilities, design and production environments; dedicated development facilities and tools, communications, information environments, training servers; and applications to support disabled people, language learning, collaborative learning, exploratory learning, and simulation and modelling; (5) Policy and Planning; and (6) Implementation--Transition and Evolution, including editorial, technological, and telecommunications scenarios, infrastructures, and evolutionary strategies. (DB)

ED340342

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Ref:XIII/F/DE1715B
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IMPACT ASSESSMENT & FORECASTS OF INFORMATION AND COMMUNICATIONS TECHNOLOGIES APPLIED TO FLEXIBLE AND DISTANCE LEARNING

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- VOLUME II: MAIN REPORT & ISSUES ANALYSES -

Analysis of key issues for the orientation of the work of sector actors in the framework of DELTA

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IMPACT ASSESSMENT AND FORECASTS OF INFORMATION AND TELECOMMUNICATIONS TECHNOLOGIES APPLIED TO EDUCATION AND TRAINING

VOLUME II - MAIN REPORT AND ISSUES ANALYSES

Analysis of the key issues for the orientation of the work of sector actors in the framework of DELTA.

This report is the summary of the results of a study performed by the DELTA unit (Directorate XIII-F) in parallel with the projects underway in the R&D Exploratory Action.

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PREFACE

This volume of the Impact Assessment and Forecasts Report on Information and Telecommunications Technology Applied to Education and Training forms part of the review process within the DELTA framework, carried out in order to assess the achievements of the programme in a broader context and to point the way forward to the future developments needed in the domain of Advanced Learning Technology at a European level. It identifies the key issues, associated requirements and options and potential actions to be taken. Thus it aims at orientating the work of the sector actors in the framework of DELTA.

The other volumes of the report are:

- Volume I: Executive Summary

- Volume III: Glossary and Annex on State of the Art of Advanced Learning technologies.

0. WHAT ARE LEARNING TECHNOLOGIES?

0.1. STATEMENT OF THE ISSUE

Learning technology covers a broad range of technologies and tools which are used in education and training.

When speaking about learning technology, we will refer to **all information and communication technologies which may be used in order to help the education and training processes.** A more comprehensive definition of learning technologies should include all the media traditionally used in distance and open learning, ie **printed text, telephone, postal services, broadcast and recorded radio and TV, but also encompassing the new media based on digital processing such as Computer Based Education, Fax, E-mail, computer and video conferencing, interactive video, multimedia materials etc**. The focus in this report will be on the 'new' technologies, but as the traditional medias still are going to play an important role in the European distance and open learning in the foreseeable future, these medias will also be be taken into account where relevant.

As learning technology encompasses a large number of topics,technological, pedagogical or economic, instead of covering just one field, research (development of learning technology) has to cover not only the technologies in their own right, but also the factors influencing the use of learning technology. These include: **pedagogic research** on the use of different learning technologies and different combinations of learning technologies in different settings (eg institutional, company based, and individual learning), **technological research** in each of the learning technologies in their specificity, **sociological research** on the macrolevel of learning and economic research on the market issues.

The description of the domain also has to take into account the series of different approaches and actors involved such as teachers, trainers, learners, publishers, software houses, broadcasters, service providers, telecom operators, etc. It must also consider the series of relevant uses of the computer according to its ability to handle remote control of objects, calculation, symbolic representations, text process, simulation, browsing, etc.

The developments in computing and communication technologies and especially the integration of the technologies already have brought about new learning possibilities in traditional classroom teaching, distance learning and selflearning. Developments in personal computer and interactive video techniques have made it possible to demonstrate, experiment, analyse and simulate highly complex processes and natural environments in the classroom which so far had not been possible. Developments in communication technologies (satellite broadcast, network developments, communication standards) have made it possible to have access to a wide range of information sources and to participate actively and interactively in distance learning schemes from even the most remote areas.

The envisaged developments in technologies such as High Definition Television, Integrated Broadband Communication Services and the development of more powerful personal computers will enlarge these possibilities even further.

All these technologies will enhance the possibilities of education, either by providing new media, including the possible new pedagogic approaches or by providing new ways of conveying those traditional ones.

There is an increasing emphasis on the need to develop pedagogical approaches, which could take full advantage of those technologies for learning, ie WHERE, WHEN and HOW learning should take place, and even WHAT to learn.

When and Where to Learn?

New technologies do not aim to substitute the existing facilities, but to complement them. When there is no access to classroom teaching, learning technologies can provide substitute means of training. It is the case for remote areas, or in domains of knowledge where the expertise is scarce and concentrated in major urban centres. When the technologies are available in the classroom, they can complement the teacher, reinforce his/her possibilities.

In a recent survey carried out by the UK Training Commission, it was stated that one of the improvements that learning technologies would bring would be the increased possibility of learning at home, when people want it and where they want it to happen.

Self pacing and self assessment are two main issues for achieving more flexibility of training.

In a major insurance company in France, specific training schemes were developed in order to train employees on their working station. This was done as an anticipation of the reduction of working hours, balancing this reduction with training facilities.

There are some concerns from trade unions about transferring training from the working time, in professional settings, to the leisure time, at home. One can then expect intermediary solutions, such as development of open access centres within companies or within local authorities, in order to avoid moving people away from their working place when they want to access training facilities.

Ongoing research will increase the ease of use of learning technologies, making them as easy to handle and connect as a piece of paper or a radio transistor, with the added advantage of being tailored to individual preferences.

How to Learn?

The interactivity of learning is stimulated by the new technologies. Interactivity modes include selection interactivity, where the learner can be guided in the choice of an infinite number of pages stored in electronic forms. It includes process interactivity, testing the learner and, according to the answers, coaching him towards given resources or exercises.

Video games provide a good example of interactivity, especially in flight and car race simulations games. They tend to emphasize mainly the psycho-motorial skills, but they require the player to be active and provide him with a new environment according to the decisions he is taking. Why could not educational software achieve this level of interactivity, and require decision making by the learner? Why could not traditional education stimulate more active behaviour?

Problem solving's pedagogy benefit from new technologies. In computational environments, the learner can test several options in order to approach a solution. In accountancy for example, spreadsheets can be used as educational tools to approach different solutions to a given problem. In a simulated economic environment, the programme can ask the learner to take decisions on prices or on taxes, and give him the simulated results of his (her) decisions.

What to Learn?

One cannot understand the major focus on learning technologies, if one does not relate it to the parallel changes which are occuring in curricula and in the learning processes themselves.

In some disciplines, knowledge is in constant evolution. There is an explosion of new facts, which eventually become obsolete. In some cases, the updating of teachers and trainers' knowledge may become more urgent than teaching the learners.

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There is a shift from passive behaviour concerning information to more and more active handling of information and communication. Professional profiles include increasing references to the use of information and telecommunication technologies.

Spread of computer uses in society tends also to accelerate a major concern for handling information and new representation tools, such as spreadsheets. Some fields become more complex, but in the meantime, information technology provide new ways for representing and interpreting them and those new representation tools become the aim of teaching. This is the case with teledetection or echography, where the study of analytical tools becomes part of the curriculum.

Moreover, people must cope more and more with complex environments. There is an associated requirement for multidisciplinary approaches and knowledge. New pedagogical paradigms must be found in order to **teach complexity**.

Below the hypotheses for "WHEN, WHERE, HOW and WHAT to learn", we must be conscious of the GAP between information and knowledge. We now know how to transfer information through technology, but processing and transferring knowledge is a much more difficult issue.

It is only when this gap is filled that we will be able to see the emergence of real **Personal Learning Systems**, allowing a synthesis between the potentially accessible knowledge - infinite and confusing - and the intentionally provided and personalised information - specific and illuminating the cognitive process.

0.2. DESCRIPTION, STATUS AND TRENDS

Several technologies are already used for learning purposes.
In the future, those technologies - interactive video, telecommunication services, computer simulations, simulators, broadcast - will converge. If cost effective solutions can be found new technical environments will institute a three-party marriage : telecommunications + computer + video-image technologies.

Issues related to learning technology cover several distinct applications. These must be clearly understood when developing specific equipment. In the following some major fields of applications are indicated:

1) **learning topics by means of computers**, including different uses of CAL as well as the use of professional software such as word/text processors, spreadsheets and filing systems in teaching. These can be used to support new courses on writing skills, data processing or information handling. In this category, we can also mention expert systems, which when used in training can bring about a better understanding of the learning processes.

2) **use of communication facilities**, such as electronic mail, video and computer conferencing, which involves new interactions and relationships between trainers and trainees.

3) **use of desk top publishing facilities**, which have an impact on the design of learning materials.

A number of new pedagogical tools are available based on these technologies:

- **Virtual laboratories**
  Experiments are based on objects, symbols, sounds, texts, etc. (eg a laboratory either to design and build electronic circuits or to teach that same process). Virtual experiments tend to be complemented by concrete physical experience in order to avoid misrepresentation.

- **Action environments**
  Real environments may be simulated in order to provide a context of an action, to place learners in situations where they have to take decisions and to apply concepts they have just been taught in order to progress in the context presented in the learning material. For example, a simulated journey through Europe would allow learners to test their mathematics and management skills, for example changing money, understanding exchange rates and keeping within a given budget. Microworlds is one aspect of such environments. In providing real world metaphors within a limited and well defined learning environment, the student interacting with it may learn the important underlying concepts. For example, he could learn geometric concepts in playing with a turtle robot, or with an automated arm.

- **Expert systems**
  There is now a growing consensus on the fact that learning systems should not focus on fact teaching, but should help learners to build their own knowledge architecture. In this respect, emphasis is put less on solutions (good/bad, true/false) but more on the process of problem solving and decision-making. Experts systems can help bringing about learning materials which will support this kind of learning.

- **Representation tools**
  This approach aims at placing learners in situations, where they are invited to apply representation tools (eg spreadsheets, databases) in order to "process" the knowledge they are acquiring, eventually by using specific dedicated software tools.

- **Intelligent tutoring systems (ITS)**
  The difference between intelligent and non-intelligent tutoring systems lies in both the quality and choice of interaction and the quality of answer analysis and adequate feedback. In intelligent systems the learners are free to choose between asking questions and being asked questions. As stated in the pre-pilot DELTA report, if the aim is to teach knowledge or skills then the feedback should correct learner errors. If the aim is to help learners to understand difficult concepts, the feedback should help and encourage those who have misunderstood to think again rather than to give them the 'right' answers.

- **Multimedia navigation tools**
  Multi media bases provide an opportunity for new kinds of encyclopedias containing text, graphics, 3 dimensional graphics, still pictures, moving pictures and application programmes. To utilise this knowledge resource in education navigation tools fitting the requirements of training and education needs to be developed. Development of such tools would be in line with the trend in education from guided learning towards open systems allowing the students to study exactly what they want to learn in their own way. For example, one could imagine multimedia resources on the Renaissance, or the Conquest of the Space where a learner could explore the scientific, artistic and economic dimensions of such events. Hypermedia are one approach to such navigation, but they could be more strongly fitted to pedagogic requirements through appropriate coaching systems.

- **Self-assessment:**
  There is an increasing concern for evaluation of the learner's ability and a need to provide tools which help the potential learner in choosing the right courses and assess the progress throughout the study. Technology could provide guidance through appropriate testing by asking learners to answer self-assessment questions prior to the choice of a given course and to perform exercises throughout the course.

- **Distance learning and broadcasting:**
  The use of television, coupled with (encrypted) satellite or videotape distribution and interaction via telephone or computerconferencing such as in EUROPACE, is now part of the learning technologies potential. An important difficulty arises with the language barrier. To overcome it, some new technical interfaces may be experimented with in the future.

0.3. REQUIREMENTS AND OPTIONS

Learning needs must be identified and matched to technology options. This is particularly crucial in domains where existing learning facilities do not fulfil the needs.

In order to provide some examples of satisfactory uses of technology in learning, the requirement has been expressed to carry on regular investigations on exemplary case studies, on which parameters of costs, uses and interests could be compared and provide an economic and pedagogic mapping of the different learning technologies. In particular, it has been stated that accompanying measures should be taken for improving information and innovation transfers to the Community, with respect to non advanced regions and sectors as well as economically advanced ones.

Another requirement has been expressed to support the diffusion of tools and methodologies which could allow a better technical compatibility, interoperability and convergence of the several existing learning technologies. If the first requirement is addressed to the learners and decision-makers, this second one is more particularly addressed to the producers of multimedia learning materials, and then to the users.

It has also been indicated that there was a need for exploring new technological environments, which could take full advantage of technology in the learning process.

There is not one single best adaptation of technology to education and research must take into account the great diversity of learning processes, users and technologies.

1. SOCIO-POLITICAL AND ECONOMIC IMPLICATIONS

1.1. ECONOMIC AND STRATEGIC FACTORS

1.1.1. Statement of the Issue

The quality of human resource development is now widely recognised as a key factor in Europe's future competitiveness - in fact it is thought by some to be the essential factor which might allow European organisations to gain a competitive edge over major rivals. At present there are no structures for ensuring that the level of training needed in order to maximise human resources will be available to industry and commerce.

The purpose of this section is to raise the economic issues which are shaping training requirements and around which priorities for new training and educational technologies must be set.

Rapid innovation in computer and communications technologies have created a dramatic increase in the need for training and retraining. At the same time they provide a possible mechanism for new and innovative forms of training. It should be noted however that training is not a hermetic issue. The changes which are taking place in training and retraining are a product of fundamental changes in the organisation of industrial production, commercial services and international trade. The possibility of a new technological infrastructure for training purposes has therefore to be related to and consistent with the experience of change in the wider economic environment. This raises a number of sub-issues which need to be taken into account.

1.1.2. Description, Status and Trends

1.1.2.1. General Economic Considerations

The EC economy has experienced, over the past 25 years, a significant shift realignment of the major sectors of production in the Community's overall gross domestic product. There has been a steady decline in the share of manufacturing and products and an expansion of market and non-market services such as financial services, transport, tourism, distribution, consultancy etc. These sectors are known to have a high 'information' content. However it is not only in the new service sector that the demand for information and information exchange is increasing. In the manufacturing sector there are significant shifts in the organisation of production provoked by, and now dependent upon, information systematic collation and exchange.

Underlying these changes are the rapid development of information and telecommunications technology and its associated software. As well as constituting significant industrial sectors in their own right, information and telecommunications technology are creating a new infrastructure through which industrial and commercial organisations will interact with their customer and supplier bases. This infrastructure represents one of the greatest long term investments of the later 20th century. In Japan alone, for example, it is estimated that by the year 2000 the cumulative cost of the infrastructure for optical communications will amount to some 65 BECU.

The impact of this emerging infrastructure on the operations of businesses and public services will be profound and it is essential that the changing style of worklife which it produces is adequately addressed by new forms of training. Current experience shows that there is already a serious shortfall of skilled personnel in the areas of new systems development, systems applications and systems operations. This point is taken up in more depth below.

In this section it is important to give a realistic sketch of the likely pace and direction of infrastructure development. The ultimate objective of the DELTA Exploratory phase is to indicate ways in which Europe's training needs can be met by advances in information and telecommunications technology. It is expected that future training materials will be multimedia in character, developing through on-line computer conferencing to videconferencing, satellite and terrestrial broadcasting, and multimedia co-work, using advances in videotext, on-line graphics distribution and stand alone interactive systems such as CD-I, VD-I, and CD-Rom.

The development of learner hardware and software (mostly P.C. based) is expected to be rapid. The market for these in 1988 was some 650 MECU. This is expected to increase to a total in excess of 1200 MECU by the end of 1990. Such a rapid rate of growth reflects the substantial investments which are being made in new training systems.

The exploitation of communications networks is a less certain feature of current activity. Sufficient investment in the telecommunications infrastructure to make it amenable to multimedia usage is too high to assume that universal coverage will be possible. Instead, selective and incremental infrastructure building will take place. As the new infrastructure is established on an incremental basis, the level of uptake and the revenues earned will be key considerations in any assessment of the value of extending broadband communications. It is essential for the training environment that practitioners are able to experiment with and utilise new communications systems. Experience elsewhere, particularly in Japan, suggests that training and education could become important users of advanced communications networks. However even on an experimental basis the cost may be high. The training community and the providers of advanced communications infrastructure are therefore in a quandary: as the new communications structure evolves the training community is unlikely to gain affordable access to multimedia communications without considerable discounting by the PTAs. If the PTAs adopt a policy of discounting this will represent a possible diminution of the PTAs return on investment. It might also lead to regulatory problems.

It is important therefore that an incremental strategy for networked, multimedia training takes full account of the economic rationale and the pattern of development of new infrastructure development.

The most likely scenario for advanced communications development, according to research under the RACE Programme, is that a series of "fibre-optic" islands will be established in key areas of economic activity. This image of an information and communications rich urban "island" has interesting implications for a European training technology strategy. It implies , at a relatively early stage, the emergence of centres, equipped with a telematics infrastructure and peopled by information workers, groups which experience high levels of innovation and with a consequent need for more regular skills updating. This might in turn imply that a European training strategy should focus its own attention on services which can be offered to the residents of "fibre-optic" islands.

1.1.2.2. The International Competitive Situation

Advances in computer and telecommunications technology are expected to have a profound effect on the geographical distribution of industry and commerce. In response to the rise of young, dynamic economies such as the South East Asian "tiger" countries, and the continuing success of the Japanese economy, both the United States and Western European corporations are expected to place ever greater emphasis on the quality of goods, their ability to respond and anticipate changes in market demand and their ability to ensure rapid distribution of their goods and services. This strategy is made possible by IT+T products and services which are currently reshaping the production process. But whilst IT+T makes such a strategy possible, its eventual success is heavily dependent on the quality of human resources. A truly competitive strategy in the new global economy has to incorporate a strategy for human resource development.

The international competitive situation therefore is inherently a training issue. It is vital to assess training and retraining provision in Europe vis-a-vis developments in competitor regions.

In competitor regions, the training and retraining of the adult workforce, as well as the quality of education in schools, is already a major issue. In the United States there are now frequent references to a "crisis" in adult learning. Both the United States Federal Government and the Japanese Government have recently completed wide ranging reviews of their school curricula which have emphasised the need for greater flexibility and autonomy in the student population. Both the USA and Japan are experimenting with, and developing considerable experience in, new learner technology including new distance learning techniques.

1.1.2.3. The U.S. Experience

As in other areas of ITT+B development, in the USA training is determined by short term demand factors rather than long term strategic planning. This point is made in the RACE strategic document "Establishing Advanced Communications in Europe". There have been moves more recently in the USA to create a context for ITT+B planning but the situation is still best characterised as unplanned. This means that new initiatives are exposed at an early stage to the rigours of the market. Many projects are therefore curtailed before realising their apparent potential. This seems to be one factor behind the move towards smaller scale or sectoral projects with a high level of quality assurance.

The National Technological University (NTU)

The NTU acts as a kind of clearing house for the delivery of technical learning programmes. It is described as a co-operative effort of 29 major engineering colleges to provide high quality, career-long education. The engineering colleges are responsible for developing courseware for NTU courses.

Seven technical programmes lead to a Master of Science degree awarded by the NTU. NTU offers 10,000 hours of graduate instruction a year, along with 1000 hours of interactive education and research teleconferences. Over 5,300 technical personnel have completed graduate courses in the past four years. More significantly, 45,000 participated in short courses and tutorials in 1988-89 alone. The NTU delivers its courseware via satellite.

MVDS Delivery of Distance Education

Instructional television delivered by microwave video distribution systems are common in the USA. Between 4 and 8 channels of education can be offered on a typical MVDS system operating in the 2 GHz band. The technology is relatively cheap to purchase and install. A 4 channel system is thought to cost in the region of $250,000 (inclusive of installation). MVDS systems in the US have a broadcast range of approx 35 km radius.

A typical and pertinent application of MVDS can be seen at the University of Boston. Boston is the regional node for the East Coast's high-technology corridor "Route 128". Due to the phenomenal success of Route 128 companies the local unemployment rate is low, at about 4%. The innovative nature of the Route 128 economy is often ascribed to the presence of a world centre of excellence in advanced technologies at M.I.T. However Boston University has played its part in local economic development by providing instructional television to Route 128 companies via microwave distribution. Although Route 128 lies in close proximity to the City of Boston, the University has found a strong demand for distance education in the high-tech sector (in this case "distance" is less of an inhibiting factor than "time". Successful companies do not want their executives or technical and sales staff to spend time travelling into the City; the difficulty of parking in Boston is another important factor).

Video Production and the Learner Environment

Another important trend which can be seen in Boston is the move away from high-tech broadcast delivery systems to high quality, customised video production. Boston University's Vice President in charge of the distance education programme believes that even microwave delivery will be phased out. In place of general instructional programmes companies are now demanding training which is tailored to their specific needs. This makes a broadcast delivery system redundant. It also increases the cost of training. The University is finding that it is less and less able to achieve cost efficiencies by creating generalised courseware which it can deliver to a wide audience. Companies, on the other hand, are prepared to pay high prices for their own instruction.

This trend indicates that "cost efficiency" in training is not a straightforward concept. A cost efficient training module can be extremely expensive. What makes it "economically efficient" is the consumer's evaluation of its utility.

American distance trainers have broad experience of trying to create "cheaper" learning and have discovered that reducing the cost of training through distance teaching has an immediate pedagogic cost. Because distance teaching eliminates much of the value of interpersonal relationships the lower economic cost has to be assessed in the context of lower pedagogic value. One way in which US Colleges have tried to improve the cost/benefit relationship is to create the right ambience for student and tutor.

This has led to a reconfiguration of the classroom. Some distance teaching modules now take place with a class of students attending in the "studio". Students in the class each have a television monitor and can follow the lesson both through their immediate access to the tutor and through the monitor. Difficulties which arise in the use of video as a medium are apparent to students in the class who can then raise questions with that tutor.

This adds to the cost of distance teaching, and it introduces inflexible structures - i.e. there has to be a College class already attending the course, and the class will fit into the conventional College timetable. Experience shows however that the quality of the course, from the distance learner's point of view, certainly improves.

Learner Workstations

Research into new multimedia workstations is being conducted at various locations in the USA. There is for example, the NeXT computer company's new multimedia workstation. There is also a venture capital funded product being developed on the Apple computer, which incorporates a facility for digital video editing; and there is an initiative by M.I.T. to coordinate multimedia workstation research and marketing for IBM compatibles. In all three cases the potential of the market for multimedia PC based technology has now been acknowledged. This represents powerful competition for the European market.

1.1.2.4. The Japanese experience

In Japan the situation in education and training is again similar to that in other areas of ITT+B. The Japanese take a long term view of training provision both in relation to the individual employee in receipt of training and in relation to planned support systems.

Unfortunately, European knowledge of technical and infrastructure developments in Japan is not good. Part of the reason for this lies in the, as perceived in Europe, rather secretive way in which many Japanese corporations have developed their training systems and plans.

Information prepared for the Commission in 1986 suggests that dedicated infrastructure development for training and education, and the development of dedicated hardware, took a low priority up until the mid-1980s. A report for the OECD showed that in almost all categories of research on learner systems the Japanese lagged behind the other Western economies. From that point on however the Japanese have given training and education a very high priority. Although they have only recently begun to develop training and education systems in a coherent manner, they have significant infrastructure advantages over Europe and the USA.

This derives from the organisation of intelligence gathering in the Japanese industrial system. Japanese corporations have already built sophisticated electronic networks to assist in industrial intelligence gathering. These include dedicated infrastructures linking Corporate headquarters with all subsidiary offices, often on a world-wide basis. Under the direction of MITI Japanese corporations are obliged to share intelligence. We understand that this has led to the creation of inter-firm networks. At the hub of the networks are intelligence databases on world markets and on competitor corporations world-wide.

The infrastructure created for intelligence gathering now represents a considerable asset for training and education which can be provided as a value-added service without additional infrastructure investment.

With an infrastructure programme assured, Japanese electronics companies are focussing on producing the hardware and software to facilitate user-friendly learning at a distance. This market is now recognised as important and the Japanese will target it in the same systematic manner that they have targeted others.

Examples of Recent Developments in Japan:

Fujitsu

Many Japanese corporations with an involvement in IT+T not only have their own electronic infrastructures. They are able to approach the training and education market with considerable experience of internal computer-aided and distance learning projects. The strong emphasis on human resource development in Japan is reflected in high training budgets (often equalling total R+D expenditure). This implies a greater degree of familiarity with the problems of adult learning than is found in Europe. Fujitsu is a good example of this.

Fujitsu is Japan's largest computer manufacturer. The company employs 60,000 people. At age 35, every member of staff is entitled to a 3 month off-the-job training course. The company produces over 100 training videos each year, and has its own Corporate Information Network System which can be utilised for distance training.

Fujitsu undertook a number of development projects for its internal purposes and some of these are now on the open market. Of particular relevance is the SCHOOL family of products. SCHOOL stands for System for Computer Helped Operation of Learning.

SCHOOL-ACE - Advanced Courseware Editor.
SCHOOL-CAL - Central Support and CAL Systems Management Software
SCHOOL-NET - LAN Support software
SCHOOL CMI - CAL package and data library control system

SCHOOL series software operates on the Fujitsu FM-7 and FM-16 personal computers. FM-7 is designed for home, primary and junior school use; the FM-16 for adult education, high school and university.

Another system worthy of note is KAPITAL. In conjunction with the KANAZAWE Institute of Technology Progress, Fujitsu has developed a LAN-based 'total education system' using personal computers with a main frame host. The Host provides a relational database to build, manage and analyse curriculum management data, application management data, student data and result data. It also provides access support to applications library, hard disk server support for intermediate store between personal computer and host.

Toyota

Toyota, like all Japanese companies, places a high value on staff training. The company has invested $100 million in a new University designed to take Toyota employees. Employees however make up only 20% of the University enrolment. Information is not available on the technology support systems employed at the University. Overall expenditure illustrates, however, the company's commitment to training. Toyota is also a shareholder in Teleway Japan Corporation, a new telecommunications common carrier and we can expect that the company will seek to utilise its network for training purposes.

INS

Expanding the market for distance training is integral to the development of Japan's Information Network System. It is promoted by NTT, the former PTT monopolist, and based on the international 64kbps ISDN standard. NTT plans a second phase of INS based on 1.5 or 2Mbps. The service features the following elements: video-conferencing, high speed fax, improved viewdata (i.e. photovideotext and voice), digital graphics and the interconnection of terminals of different speeds and types.

In the home, INS is expected to provide basic distance learning - though this may simply refer to an extension of company 'acculturation' programmes. Information provided to the Commission suggests that a joint venture between NTT and NEC, Hitachi, Fujitsu and a major software publisher, will develop the network for on-line training and education delivery.

Other Developments in Distance Learning in Japan

It is already apparent that Japanese corporations and Japanese society in general will soon be able to take advantage of whatever efficiencies can be made available through networked distance learning. Corporations provide a considerable ready-made source of demand for this type of learning. It is important to consider also the level of demand in Japanese society in general.

Japan has a well developed source of extended education. There are over 300 private universities, as well as approx 100 public national universities and 34 local public universities.

In 1982 176 private universities offered extension courses. 78 national public universities and 22 local public universities offered extension courses. The courses are non-accredited. However, in all, over 250,000 people took part in these courses in 1982.

1.1.2.5. Developments in Europe

This section reviews European experience of innovative schemes and innovative technologies designed to aid the special problem of European training.

A number of these schemes, in addition to DELTA, are sponsored by the Commission.

COMETT

COMETT is a Community programme of cooperation between enterprises and universities in the field of technology training and technology applications. It has been operational since 1987 and is due to enter its second phase in 1990. COMETT has helped establish over 125 University-Enterprise Partnerships around Europe and has sponsored almost 200 joint continuing training projects, and 90 multi-lateral training projects using multimedia systems.

The basic aim of COMETT is to contribute to the development of competence in European technology, and contribute to the reinforcement of internal economic and social cohesion. Phase II of COMETT is aimed at deepening industrial and educational ties in the SME sector and in broadening the geographical scope of the programme to include more activity in the peripheral regions. COMETT II will be funding collaborative pilot projects in training technology, particularly aimed at establishing systems for distance learning. A number of complementary measures are planned under strand C and these could have implications for the DELTA Programme.

EUROTECNET

EUROTECNET is a programme of action on Vocational Training and New Information Technologies. It has been operational since 1985 and in phase I created a network of more than 130 projects which interacted with each other, exchanging experiences and transferring lessons and good training practices. The programme involved trainers, policy makers and social partners in technological development in each of the Member States. The second phase of EUROTECHNET is designed with two principle objectives:

- to improve the capacity of provision for initial and continuing training in the European Community to take account of and adapt to technological changes and their impact on employment, work and qualifications

- to assist in the design and development of future training provision in order to take account of the implications of future technological developments for new occupations and the necessary skills and qualifications

ERASMUS

ERASMUS is the European Community Action Scheme for the Mobility of University Students. It has a number of Action Lines all designed to improve the facilities for students in tertiary education to gain experience of other European cultures. One of its action lines is designed to develop a European Community Course Credit Transfer System. This is a six year pilot scheme involving 80 higher educational institutions.

Non-E.C. Initiatives:

Quite apart from Commission programmes a number of interesting initiatives has emerged from the academic world and from the IT industry.

EADTU

The European Association of Distance Teaching Universities (EADTU) was formed in 1987.

The objectives of the EADTU are:

- to promote higher distance education in Europe
- to support bilateral and multilateral contacts between academic staff in participating institutions
- to support cooperation in the fields of research, course development, course transfer and credit transfer
- to develop new methods and techniques for higher distance education, including new technologies and media.

It contains two types of members: the independent non-profit higher distance teaching institutions; and consortia of Universities or institutes of higher education which teach at a distance.

SATURN

SATURN was formed in 1987 as a University Enterprise Training Project under the COMETT programme by the major Distance Teaching Universities and major private companies which either use distance teaching methods in their training programmes or which are producers of learning material.

SATURN have been very successful in disseminating information concerning distance teaching and open learning methodologies to the private sector. This have been done by newsletter, as well as in a series of workshops, the annual agoras and by consultancy. SATURN is now a self financing body and has established a permanent headquarters in Amsterdam.

EUROPACE

EUROPACE was established in 1987 by major actors in the IT&T sector. Its aim is to provide high quality upgrading courses in the fields of IT technology and technology management. EUROPACE provides the courses via satellite to receiving centres in different parts of Europe. It also offers additional services such as special events via satellite, and an interactive feed back procedure by computer conferencing.

EUROSTEP

EUROSTEP was formed in April 1989 as an association to organise the educational use of the Olympus satellite. EUROSTEP coordinates all the educational programming on Olympus, including the scheduling of programmes. There are some 300 educational institutions which intend to conduct distance learning experiments on Olympus. The schedule represents more of a testbed, at this stage, than a comprehensive training channel.

Many of the projects reviewed in this section have a common theme - that is to improve the level and frequency of training through the use of new technologies. A more tightly focused theme is apparent in about half of the projects: *to develop training courses for new technologies through the use of new technologies*. Despite the similarities, it can't be said that these projects comprise one training strategy for Europe. Whilst this may not appear problematic in relation to developments in the USA, it certainly suggests that the Japanese are further advanced in their plans to utilise advanced communications for multimedia learning. It might also be seen that in the United States there is a longer tradition of Universities and other higher educational institutions providing training to industrial and commercial via distance communications systems. In particular the use of microwave video distribution for training seems to have been quite sucessful but has yet to be applied in Europe. Both in the United States and Japan established services could provide a platform of experience for training via advanced communications. Experiments in Europe whilst exciting in their own right do not yet have the same substance.

1.1.2.6. The Internal Market

In the context of international economic and strategic issues, the completion of the internal European market is of extreme importance. At present the Member States have no universal system for mutual recognition of professional training courses. This creates significant labour mobility problems which our major competitors do not face. The accreditation issue is currently being addressed by the Community's ERASMUS technical unit. However behind the accreditation issue lie a number of equally significant problems.

Whilst the USA and Japan can rely upon national markets for training courseware, in Europe the linguistic and cultural diversity of the Community restricts the potential market for private sector training suppliers, and potentially inhibits their willingness to invest in costly production and distribution facilities.

The lack of harmonisation in copyright legislation deters multimedia publishers from placing new multimedia learning materials onto the European market.

The market for learner hardware and software is fragmented due to a lack of standardisation and to the difficulties encountered in securing a single distribution network for learning material.

The educational sector is a key player in the PC market, and as a single group is the most important purchaser of P.C. equipment and peripherals. As much as 35 - 40 % of the European market for P.C.s is accounted for by student/faculty purchases. Student/faculty purchases doubled in quantity in 1987/88 making it the single most dynamic factor in the PC market. Where Europe has strengths, such as that demonstrated by Olivetti, it relies to some degree on exploiting the companies home market. Olivetti, second in the list of suppliers of to primary and secondary schools in Europe, has relied heavily on its dominance of the Italian market where it enjoys 64% market share.

This fragmented market is vulnerable to overseas competition. The market for P.C.s in Europe's higher educational institutions is already dominated by U.S. suppliers. Apple and IBM between them enjoy an estimated 46.5% of the market, with the nearest European supplier Olivetti has only 10.3%. The dominance of Apple Mackintosh, with 26.9% market share, imposes operating standards which European producers are now forced to emulate.

The cumulative effect of these problems is to place Europe at an unnecessary disadvantage. The creation of a unified market for learning - incorporating cross national courseware production between centres of excellence, cross national provision and accreditation of professional training, and a more dynamic European supply industry - are essential elements in the creation of the European internal market. On the one hand the Community is dependent on exploiting advanced systems in order to ensure widespread improvements in human resource development. On the other hand the inherent diversity of the Community inhibits the development of its most valuable resource.

The strategic orientation of competitors, in training and training systems, and their strong market position in business electronics, and their relative cultural and linguistic homogeneity, raises the possibility of a Europe which is comparatively weak in terms of human resource development and weak also in the expanding home market for learner systems.

1.1.3. Requirements and Options

The strategic aim behind the development of new learning systems is to create the conditions in which European organisations can access, when and where they need to, the necessary knowledge, expertise and skills development resources which will allow them to compete effectively in the changing economic climate of the 1990s. As a preparatory measure it is important that a European solution to human resource development is recognised as a key strategic consideration in future economic development. The rationale for a European solution hinges in part on the importance of the Internal Market. New technology may well offer the possibility of unifying training provision in the Community, thereby contributing to a more homogeneous labour market.

However there is a supplementary rationale within the actual changes taking place in industrial and commercial reorganisation provoked by, and enabled by, advances in IT+T. This reorganisation has a geographic - or "spatial" - element as well as a structural element. New technologies are encouraging industrial concerns to relocate to areas where human resources as well as communications resources are most attractive. This means that the human element in the production process - the quality of life available for workers for example, is more important consideration than in the past. It also has an effect on the structure of industrial sectors, provoking the geographical concentration of specialist suppliers. This threatens to widen the disparities which already exist within the Community between advanced industrial areas and disadvantaged peripheries. This set of disparities can perhaps be reconciled if the peripheral regions can access high quality training supplied by centres of excellence.

The requirements criteria for a European training technology strategy should therefore take into account:

1. The likely development of 'fibre optic' islands and the concentration of information workers in centres of excellence

2. The dangers of overconcentration brought about by the structural adjustment of the European economy

3. The contribution which new technology can make to a European training strategy

4. The importance to the PC and PC-peripherals market of the educational domain, and the current domination of some parts of this sector by overseas vendors

5. The strategic use of new training technologies by overseas competitors

6. The stronger traditions of providing training 'at a distance' to corporate organisations in competitor countries

7. The importance to the internal market of a homogeneous labour force.

These factors point to the need for a strategy which is European in character and which takes account of hardware, software and network technologies. In addition to the benefits to the internal market it is essential that new technology is used to overcome linguistic, cultural, and geographical barriers. In the important area of courseware production, a truly European market for training products ought to provide significant economies of scale and encourage a higher degree of private sector investment in new multimedia learning technology and products.

1.2. IMPLICATIONS FOR EUROPEAN INDUSTRY

1.2.1. Statement of the Issue

Structural change within European industry, allied to advances in new technologies, are creating new tasks, new organisational forms, new work patterns and new demands on the workforce.

The creation of the 'information society', a post-industrial economy in which traditional manufacturing skills and traditional forms of work organisation gave way to an 'information' based economy, was first predicted in the early 1960s. The actual realisation of an economy in which information workers exceed blue-collar workers as a proportion of the labourforce has taken over two decades to emerge. However now that it is a reality its implications go much deeper than was first realised.

The 'information society' is not simply a new form of production and distribution. It has wide implications for the formation of competitive strategies in firms. "Information" is the basis of competitiveness. It is not simply the consequence of technological innovation. Information technologies are best implemented in the context of flexible competitive strategies and it is the strategic use of IT+T which is now permeating every worktask.

The creation of the 'information society' in the western economies is not simply a consequence of advances in IT+T. It is also a result of a global reorganisation of production in which the newly industrialising countries have developed a dynamic manufacturing sector, leaving many western industrial organisations with serious competitive difficulties in mass production goods. One consequence of this is that western organisations, particularly European, have begun to utilise new information technology to realise higher quality goods, produced in flexible manufacturing systems. These new production systems are recognised as a key competitive strategy for Europe. But they entail significant adjustments in the qualities which staff bring to their jobs in small, medium and large enterprises.

Part of the readjustment process involves developing an adequate understanding of the potential of new systems at all levels within existing organisations. Training is therefore both a prerequisite of successful structural adjustment and an essential continuing obligation to ensure maximum competitiveness.

The structural readjustment of the European economy is, however, only one factor imposing new training obligations.

1.2.2. Description, Status and Trends

Four major factors are forcing a reappraisal of training and education in Europe and in the process are changing the character of this sector from that of a traditional supplier of services into a newly competitive sector in its own right.

1. As already stated the modern economy demands a more frequently changing skills base than at any time in the past. Far greater skills flexibility is required of employees. This means that more training, and a new training profile for the individual's career, are both necessary if Europe is to achieve continuing competitiveness.

2. Secondly Europe's changing demographic profile is raising the demand for mid-career training. From now until the turn of the century there will be a dramatic decrease in the school-leaving age-group as a proportion of the total population. The annual excess of births over deaths dropped from 8 per 1000 to 2 per 1000 people, between 1960 and 1988, leaving a proportionally reduced youth population entering the labour market between now and the early 21st century. With fewer entrants to the labour market, industry and commerce will have to place more emphasis on the development of their existing human resources. At the same time, competition for highly qualified staff has taken on a new international dimension. European industry has to compete to retain its best employees, placing even greater responsibility on human resource development.

3. It has been calculated that the average employee now requires four periods of substantial retraining during his or her career. In some sectors of industry the level of innovation is forcing even more dramatic training requirements on to employers and employees. It was estimated, for example, in a study conducted for the Commission of the European Communities by the Battelle Institute, that high-tech related professional occupations will grow at a rate almost twice as fast as overall employment during the next decade.

4. The increase in demand for training has stimulated new approaches to adult education. One consequence of this is that the private sector training industry in the USA, Europe, and Japan is developing rapidly and it now a competitive sector in its own right. Although there is no indication, yet, of the overall size of the European market for training, the market for learner hardware and software is expected to double between 1988 and 1990 (from 630MECU to 1300 MECU). Developing the training market is therefore an important industrial strategy, over and above its contribution to wider economic performance. The increasing demand for training in Europe could at present be met by overseas organisations. It is known for example that Japanese companies consider the European market for learner software and courseware as a legitimate target for future export expansion.

1.2.3. Requirements and Options

There is a need for increased collaboration between industry and education to meet the needs of both large concerns and the particular traditions and requirements of Small and Medium enterprises. The following two sections deal with these issues in greater detail.

1.3. LARGE ORGANISATIONS

1.3.1. Statement of the Issue

Changes in the external environment, in production precises, and in logistics are transforming worktasks.

Large organisations are increasingly dependent on information related activities simply in order to minimise the possible losses created by uncertain economic conditions. In addition to this 'control' function, large organisations (as well as SMEs) are increasingly turning to IT+T to create more effective competitive strategies. In all cases the application of IT+T raises the need for staff with flexible skills able and prepared to update their knowledge and expertise as necessary.

1.3.2. Description, Status and Trends

1.3.2.1. Uncertainty and Risk

Since the 1960s there has ben a rapid increase in the size of firms in the OECD. The reasons for this are manifold but more important than the reasons are its consequences at different points in the trade cycle. Since the 1960s firms have grown in order first to realise economies of scale and then to ensure a dominant or near dominant market share. During the 1960s, rapidly increasing sales volumes made tight, centralised decision making and control in large organisations a relatively low priority. Since the early 1970s however there has been considerably more emphasis on co-ordination and control tasks.

The major factor contributing to this new emphasis was the slowing of economic growth following the 1974 oil shock and subsequent uncertainty in the commodity supply chain and in the currency exchange rates. This situation was summarised in a report for the Community's FAST programme by OSPRI:

"In financial markets, fundamental changes have seen the transition to a system of floating or semi-floating exchange rates and much greater oscillation in traded commodity prices. As a result of these changes, firms have found that failures to monitor the evolution of portfolios of currencies and raw material assets on a continuous basis can lead to large financial losses ...

Similar forces have encouraged the expansion and centralisation of commercial information. With increased uncertainty about input markets, firms have sought to monitor the evolution of input prices more carefully At the same time they have become increasingly active in gathering information about market developments, such as the evolution of sales, in order to optimise product distribution."

These developments have been accompanied by increased intercorporate links in order to reduce inventory costs and to optimise the interplant distribution of raw materials, semi-finished products and spare parts.

1.3.2.2. New Competitive Strategies

Although some new technology systems have been adopted in order to help build a defence against risk and insecurity, this is clearly only a part of the story. New technology in design and production processes has always been at the heart of competitiveness between firms. Technologies which firms have adopted through the 1980s are changing the style of work tasks. The process of innovation has appeared rapid. However there is scope for even more dramatic levels of change.

It has been calculated that even though information related strategies are now quite prevalent in the production process, as much as 95% of a products in-factory life is spent queuing or moving around. Only 2% of its in-factory life relates to added-value tasks. Product 'waiting time' and product inventory levels are two areas in which European industry can still improve its competitiveness vis-a-vis major competitor areas such as Japan. Improving this situation implies greater levels of integration in information systems, and the development of even higher levels of information-related tasks.

1.3.2.3. Logistics

Industry and commerce have also changed the nature of external relationships - relationships with supplier companies, marketing organisations, retail and wholesale outlets. It is not uncommon now for retailing organisations to create a information chain which stretches from the customer at the shop till to the supply sub-contractor in a different part of the country or indeed in a different part of Europe.

The introduction of Electronic Document Interchange protocols is bringing nearer the day when most functions within the supply chain will be performed electronically.

Research into road informatics, into EDI, and into office automation are each playing a role in changing the nature of previously familiar and traditional tasks.

1.3.2.4. Required Advance

The European Round Table's Working Group on Education has already indicated that advances are needed at all levels of education in Europe, including the revitalisation of basic education, the promotion of technical education at the tertiary level, vocational training and managerial training.

In each case there is a strong technological component in the revitalisation process. Even in basic education the ERT Working Group refers to the need for multimedia methods.

In Technical and Professional Education the ERT refers to the lack of long term targeted studies in major fields of technology for working adults. A European framework for continuing education, preferably utilising all available means of communication, is a necessity.

1.3.3. Requirements and Options

Greater collaboration between industry and education for the re-education and further education of adults. Creating a European context for vocational education and training.

A European Educational TV Network operating a European curriculum could act as an important infrastructure service for a European vocational education system.

1.4. NEW LEARNING TECHNOLOGY AND THE SME.

1.4.1. Statement of the Issue

The Small and Medium Sized Enterprise (SME) will grow in importance in key sectors of the European economy. Its growing importance will be based on new forms of production and on new organisational principles, both of which create new training needs.

Small and medium sized enterprises already account for approx. 80% of European GDP yet, often, are least able to cater for their immediate training needs. Their importance to the European economy is expected to increase. There are a number of reasons for this. The increasing sophistication of modern products makes some forms of mass production obsolete. For example the inclusion of higher levels of electronic components in car manufacture has created the need for skills and R+D inputs which do not exist in traditional automotive manufacturing companies and which cannot easily be integrated into traditional assembly line methods.

1.4.2. Description, Status and Trends

Changes in the pattern of consumer demand in Western Economies are another decisive factor. Increasingly it is the quality of an item, measured by its comparative rarity, its fashion, which is decisive in consumer choice. This implies that production units become flexible enough to produce in small batches and to switch production runs between different products to meet fluctuating and idiosyncratic demand schedules. The growth of just-in-time manufacturing systems represent a chain of information linking the consumer, retailer, wholesaler and producer permitting even shorter periods in which the consumers taste for fashions can stimulated and satisfied.

It can be anticipated that development in ITT+B systems and networks will accelerate this trend. The dominance of large production units, whose competitiveness is based on automated high volume production, and which has been a feature of the European economy for many decades will decline in favour of flexible manufacturing in comparatively small production units utilising Computer Integrated Manufacturing techniques.

Originally designed to reduce the 'human' content in production systems, CIM has in fact had the opposite effect:

"The CIM factory seemed to be the new approach of the technocratic ideal. However, it has become evident that the CIM factory (when it eventually exists) will not be an unmanned factory. Contrary to earlier automation technologies which try to substitute shop floor personnel with machinery, CIM is a communication tool which influences organisation and co-operation inside and outside the enterprise. It provokes change in skills and managerial competence."

The FAST report points to three features of CIM production systems which each have implications for the level and variety of skills development needed to secure the competitiveness of SMEs:

1. Machinery will be built as a modern tool to supplement the competence of workers and will be further assisted by computer programmes. This implies a level of technical acompetence which might not have been expected of shopfloor workers under large scale production.

2. The SME as an organisation must be developed in order to respond quickly to changes in demand. Organisational technologies and the firm's structure have to support a changing work environment. This creates the need for new organisational and office support systems.

3. Worker skills and management skills not only have to increase. They must become more flexible.

4. External relations will become increasingly important to the SME. Collaborative supply chains such as those found in the Italian textile industry are now used as a means of funding investment in new computer systems for payroll, V.A.T., and other legal and accounting procedures. Social skills therefore become an important element of SME development.

Technological innovation is therefore transforming the capital requirements, organisational structures, and human resource requirements of many SMEs.

SMEs spend considerably less of their resources on training. Data on SME training in Europe is generally inadequate. However in France very good data is kept on training. French companies are obliged by law to spend no less than 1.1% of their gross annual wages bill on staff training and to report on how this money has been spent. Using French data as an indicator of the pattern of training in the Community as a whole it appears that the larger the size of firm, the greater the proportion of workers who will have attended training courses:

Size of Firm by no. of employees	% attending training courses in one year
10 - 19	5.5%
20 - 49	6.8%
50 - 499	13.4%
500- 1999	22.3%
2000+	34.9%

Source: CEDEFOP

1.4.3. Requirements and Options

Part of the problem of providing adequate training lies in the way in which training is conceived - that is as an institutional activity which is 'attended' as a formal learning event. Key economic actors such as Small and Medium Sized Enterprises, however, have a different tradition of knowledge acquisition. SMEs often rely on informal sources of information and knowledge. This is often acquired through personal contacts or ad hoc inquiries. It can perhaps be characterised as a form of 'grapevine' learning. Judged by any formal set of criteria, therefore, SMEs have a weak training/learning tradition.

Attempts to address this problem through expanding conventional training or through existing 'distance' learning models, whilst a necessary step, are likely to prove inadequate. This is partly attributable to the scale of SME training needs - SMEs account for 80% of Europe's Gross Domestic Product and are expected to become an even more significant aspect of international competitiveness as their functions as a source of flexible manufacturing and as niche suppliers increase. But it is also attributable to their SMEs own learning traditions. In order that SMEs can benefit from advances in new learner technology, these traditions have to be taken into account. A new way of conceiving training requirements and provision is therefore needed.

New technologies should be harnessed in such a way that they emulate SME training traditions, i.e. a form of electronic 'grapevine' capable of providing 'just-in-time' training, or expertise, or counselling as and when it is needed would be an appropriate model.

Options: Creation of new service infrastructure for SMEs
Provision of shared training facilities for SMEs
Development of SME Training Broker services

1.5. PUBLIC AND PRIVATE SECTOR ASPECTS OF NEW TRAINING TECHNIQUES

1.5.1. Statement of the Issue

The organisation of training in some Member States has traditionally been supported by public expenditure. There is now a reorientation towards support for private sector training supply. The responsibility for investment training needs to be clearly allocated between the public + private sectors. National differences make it difficult to create a European strategy.

The role of the private sector in a learning technology strategy is becoming increasingly important. Private sector organisations are already investing in experiments such as EUROPACE. The development of innovative systems such as CD-I are private sector initiatives. Because industry and commerce is now organising more on a European, indeed a global, basis the responsibility for resolving the training problem will increasingly pass from national Governments to industrial and commercial corporations. It is doubtful whether there is yet sufficient strategic concertation of public and private resources.

1.5.2. Description, Status and Trends

Training and education in Europe has usually been a public sector or quasi public sector activity. Policy orientation in some Member States is now changing. A private sector training industry is emerging with the active encouragement of some Governments.

In the UK for example during the mid-1980s training policy for young people was organised around new training companies established specifically for the purpose of providing Youth Training.

Building on vocational education and training models in the USA and in the Federal Republic of Germany, the UK Government has now introduced a system of Training and Enterprise Councils (TECs). The TECs are due to take over the responsibility of allocating Government money in vocational training from the Government's Training Agency. They will be established as limited companies, with Director's appointed from major organisations in the particular region of the country which the TEC serves. The TECs will also, in most cases, acquire funding from local industrial and commercial organisations.

This changing policy orientation reflects concern that industry and commerce needs to be able to define its own priorities. It suggests that some Member States would wish to see considerable involvement from the private sector in defining priorities at the European level, and in funding the implementation of new training technologies.

This however creates the risk, that as State involvement declines, the responsibility for developing and implementing a learner technology strategy is not clearly allocated. At a crucial point of economic transition, developments in the training domain may suffer.

As well as encouragement given to industrial collaboration in training technology initiatives, encouragement is also being given to private sector suppliers of training in some Member States. In competitor regions, especially in the USA private sector training supply is a dynamic industry. Given the expected shortfall in new training services, the European training market is vulnerable to overseas competition. It is known for example that Japanese microelectronics companies are keen to provide infrastructure equipment and services for training in Europe.

The European private sector training industry therefore needs to be developed. It has a role to play in supplementing the resources of the traditional educational structure.

A report for the Community's FAST programme describes how, in key industrial sectors with high information content, the traditional educational system, has been slow to respond to industrial needs.

"Time lags of ten years and more between industry research and university training are not uncommon. Most of this rigidity is due to administrative, structural and legalistic obstacles to the transformation of discipline and tenure oriented universities.

Hence new training and retraining concepts have been tried largely outside the traditional university system...

While the training structures for "brainworkers are moving it appears that the basic retraining problem of making front-edge systems know-how available to those brainworkers on-site who might be in most need of it has not yet been solved."

The same report points to emerging training structures:

"...professional retraining endeavours in the high tech sector appear to be increasingly accompanied by the emergence of new, "intermediate" organisations with more or less close relations to traditional training institutions."

In place of traditional educational services, these sectors have developed their own training and exchange forum. Such initiatives are clearly a way of ensuring that supply adapts to demand.

It is possible that dynamic sources of private sector supply could aid this process of technological innovation in training. This potential needs to be investigated. What is its strategic role in a period of rapid innovation? How might private sector training supply be encouraged to use new technologies? Can the industry be fostered so that it is able to make R+D initiatives of its own? These questions are difficult to answer.

There is perhaps a case to be made for ensuring that public and private sector training organisations compete on even terms. In this scenario it would be necessary to inquire into the possible benefits of compulsory competitive tendering for essential training and educational services where it is evident that a private sector supplier can provide the same level of service as the public sector.

1.5.3. Requirements and Options

The Community should ensure that the process of implementing new technologies in learning receives adequate support, as the balance of responsibility between the public and private sector is redefined.

The Community should take account of the potential role of the private sector in its strategic inquiry into new learning technologies.

At present there is no Community-wide forum where in this domain strategy can evolve from the perspectives of both the public and private sector. Such a forum is essential if the benefits of public/private collaboration are to be realised.

1.6. THE REGIONS OF EUROPE

1.6.1. Statement of the Issue

The diffusion of IT+T threatens the less favoured regions of Europe. IT+T could lead to an even greater concentration of economic activity in urban centres. Using IT+T to disseminate training and education to less favoured regions however could make these areas more attractive both for living and for industrial relocation.

In Europe, the designation 'peripheral' region implies relative economic disadvantage. In terms of training and education the less favoured regions of Europe suffer from a double disadvantage. The less favoured regions are generally remote from major prosperous urban centres - though this remoteness may not be due to great geographic distance, it does imply that prosperous urban centres are less accessible to people on low incomes. Because they are remote, the opportunities for accessing education is often limited. Peripheral regions are also likely to have lower income and employment opportunities.

This leaves peripheral regions with relatively low access to education and makes them unattractive for people who are high educational attainers. Distance and open learning technology may have a role to play in raising access and improving the attractiveness of these regions.

But peripherality is not only a matter of geographic distance. Many urban areas, undergoing a slow process of structural readjustment, are falling behind in the adoption of IT+T. City centres are poor and these areas are as culturally and educationally impoverished because of lack of innovation as are the remote rural areas.

1.6.2. Description, Status and Trends:

Text based instruction, ie printed material, still forms the core of most distance learning systems. There is an increasing use of alternative media and already a large number of experiments are being conducted in educational services for peripheral areas.

A number of Scandinavian Countries including Denmark are experimenting with telecommunications networks for training, education and cultural enrichment. These are often referred to as Electronic Village Halls, or more formerly Information and Community Service Centres. These projects are primarily designed to tackle the problem of rural isolation. The project leaders have decided that, rather than provide services to individual dwellings. The best option for rural areas is to concentrate facilities in local'village halls'. The 'village halls' typically consist of satellite T.V. reception, teleshopping facilities, interactive electronic Citizens Advice services, and distance education and distance working using a concentration of IT facilities.

The Information and Community Service Centres originated in Denmark in 1984. A characteristic of their location in Denmark is that they are in areas of sparse population and higher than average unemployment. A recent development is the siting of an electronic village hall in an urban area of Odense.

A recent report from Denmark states:

"Through the provision of improved educational facilities and by rendering more immediately accessible information of public interest from centres of regional and national government, the ICSCs are intended to redress some of the educational and political disadvantages faced by geographically marginal populations."

Similar schemes are now underway in the United Kingdom. British Telecom has established an ISDN network in the Highlands of Scotland and a network service agency which provides shared computer time for small businesses in the rural Highlands.

Derbyshire County Council in the English Midlands is now embarking on an electronic village hall project along the lines of those established in Denmark. More comprehensive IT programmes are being developed in the French Loire Region .

In Manchester in North West England the City Council is collaborating with towns in Germany, Spain and Holland to develop network services for deprived inner city areas. There is expected to be a strong training component in this.

1.6.3. Requirements and Options

The special needs of non-prosperous areas of Europe, whether urban or rural, have to be recognised. Training and education via electronic networks can help familiarise people with the potential of IT+T, help create an information culture, and offset historical educational disadvantage.

The Strategic Review of Flexible Learning has recommended that large scale network experiments be conducted in Europe. There are already examples of national initiatives such as the Electronic Village Halls which could form the basis of larger cross-national IT+T experiments.

A network service agency which would promote and link social experiments in IT+T in different areas of Europe.

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2. POTENTIAL MARKET DEMAND AND PROBLEMS OF SUPPLY

2.1. MARKETS AND NEEDS

2.1.1. Statement of the Issue

New learning technologies can be assumed to have an important role in enhancing learning in the workplace, in the educational sector and in the home. However, the uptake of new multimedia learning technologies is far from assured. Cost is a major inhibiting factor especially in the years when new technologies first arrive in the market. It is also true to say that emerging technologies are not all complementary to each other. There are competing systems which have yet to identify clearly with a particular market segment.

The issue is to define, realistically, the likely pace of innovation and market uptake of different systems, in the light of critical cost factors.

The introduction of new learning technologies tends to follow a typical demand and supply curve. At the point of introduction new technologies are expensive and tend to be used by organisations with sufficient resources to invest in new techniques as a means of gaining a short term competitive advantage. As the advantage is proven, more firms invest in innovation and the cost of products declines. As costs decline, the market for a product broadens creating a further knock-on effect, reducing prices to the point where a product enters the buying range of the mass market. This pattern has been observed in the general consumer market with products such as video cassette recorders and compact disc players, and in the business market with computer workstations and mobile communications.

In the learning domain, critical cost factors inhibiting the mass market can be identified in the production and distribution of new training services. These all bear on the development of the training market. For example the electronic delivery of new training services can be achieved at a comparatively low unit cost (cost per learner served) if the market is sufficiently well developed. On the other hand a significant reduction in the cost of producing training materials, or a significant reduction of distribution costs could bring training services within the reach of a wider market - such as the small and medium sized enterprise and the home learner.

In order to understand this process more clearly the range of technologies likely to be used as part of new flexible learning systems has to be defined and critical cost factors identified.

Critical costs factors can be identified in the three areas already mentioned - production of multimedia materials, distribution of multimedia materials, and the cost of receiving terminals. In the following list those functions where costs are high and where potential exists to reduce costs are marked with an asterisk.

Production

The production of multimedia materials falls into two categorise: the authoring of materials, their design and testing; and the actual compilation of multimedia products - film and videoproduction, text and graphics editing etc.

Authoring

• Authoring software
On-line conferencing
• PC/multimedia workstation
Desk top publishing
Story board facilities/programme simulations
Monitoring student progress

Compilation

Text production
• Film and video cameras for vision sources
Sound sources/• computer graphics/animation
• Video editing - analogue and digital
• Digital effects
• Disc simulation
Publishing
• Distribution - There are various media through which training materials are distributed.

Distribution

• Satellite
Microwave
• Cable television
Conventional telecommunications
• Digitisation and ISDN
Video conferencing

Finally there is the cost of terminal reception equipment.

Reception

Television
Radio
Video recorder
Peripherals
Satellite broadcast reception/cable TV
• Personal computer/workstation

2.1.2. Description, Status and Trends

2.1.2.1. The Production and Distribution Chain

Authoring:

Authoring in the multimedia environment consists of a range of design operations to ensure that courseware is compatible with pedagogic objectives and to prepare material for video or other multimedia compilation. As with all multimedia production, the actual compilation is the most expensive feature. Multimedia products which are compiled from moving image sources, and from digital graphics and effects, are expensive because of the manpower and technology costs of generating high quality images. The authoring process is as much a planning exercise as it is pedagogic. The better and more competent the planning of compilation and sourcing, the lower the overall cost of production.

Programme compilation

The cost of producing audio visual material is generally high. The past 8 years have seen several phases of innovation in, for example, broadcast technology with the introduction of 1" video formats, the high band U matic and Betacam. Cheaper video formats tend not to meet quality specifications needed for good communications.

Video production costs per hour based on BBC figures 1986/87

Documentaries	125,000 Ecu
Education	125,000 Ecu

2.1.2.2. Distribution

Distribution media are important of network training services because of their cost and because their availability is crucial to long term development. Increased supply of distribution media generally implies that the cost of distribution will fall. There are, however, distribution media such as microwave video distribution which are relatively low cost but seem unlikely to be developed for educational purposes in Europe.

Satellite

It has been calculated that the number of satellite transponders available for television signal distribution could increase to above 200 by 1996 from their current level of under 50. At present there are two educational services operating via satellite - the service on the Olympus satellite, and EuroPace operating via Intelsat. British Aerospace Communications are planning the launch of a new business satellite service which will include some training.

Satellite services in Europe are still a quasi-monopoly. Eutelsat, which supplies space segment, is owned by the PTAs of the European countries. PTAs have near monopoly rights on the uplink of signals. The cost of space segment and of uplinking services tend therefore to be artificially high.

Current transponder rental costs of 3 - 4 MECU per annum or 1,400 Ecu per hour, based on charges levied by the ASTRA satellite, can be expected to fall over the next few years as the number of transponders increase and as private satellite service providers in the USA target the European market. Increased competition in uplinking is also expected to bring prices down.

Microwave Video Distribution Systems

At lower transmission rates an MVDS system is, from the distributors point of view, one of the cheapest transmission media. System installation costs in the USA have been as low as $ 250,000 for a four channel service.

Computer Conferencing

Computer conferencing systems now exist on a number of e-mail hosts. Most operate in flat ASCII and are therefore not able fully to facilitate the co-authoring of documents. Distribution between e-mail hosts is difficult due to complex addressing systems. Many deliver "mail" only twice or three times a day, so the medium in not making use of the real time advantage offered by electronic communications. New Unix-based systems are gaining ground due to their ability to transfer structured documents and graphics. The time element is still a problem because of the cost of high baud rate modems.

Computer conferencing in training is low cost but is also a low quality from of communication, especially for learners.

Conventional Telecommunications

The telephone as the primary means of electronic communications has a high penetration rate in most European countries. Two significant developments will improve the service from a training point of view: digitisation to the end user, and the implementation of ISDN.

	Subscriber lines per 100 inhabitants	Digitisation to end user %
Germany	45.6	2.0
France	44.6	55.0
UK	40.8	9.6
Italy	33.3	13.0
Spain	26.2	7.0
Netherlands	42.7	7.4
Belgium	34.5	1.6
Denmark	52.0	12.0
Greece	35.0	0.0
Portugal	15.8	0.0
Ireland	22.3	42.0
Luxembourg	45.9	12.0

Digital Communications to the End User and ISDN

The digitisation of the network is proceeding rapidly and the average proportion of user links to digital local switch in the Community is expected to increase from 17% in 1987 to 35% in 1990. Commercial ISDN is available in 4 Member States - France, Germany, the Netherlands and UK.

Image transfer at present comprises only 0.3% of telecoms services revenues. These are likely to grow at approx. 20% per annum. Mobile communications services at 0.4% in 1987 also expected to grow rapidly.

Videoconferencing

Videoconferencing can be both a high and low cost activity based on per capita attendance.

Sample costings from France Telecom's series of video conference training sessions help illustrate the point.

Gross Costs of Video Conference Training Sessions

Amortisation	20 KF
Satellite Transmission	35 KF
2 Mbit Transmission	30 KF
Production/realisation	40 KF
Total	125 KF

This provides for three interactive centres with 20 to 30 people at each, a cost per unit for 1.000 F.

Configured in a non interactive mode the numbers participating can increase to as many as 3.000 with additional overheads of only 50 KF, reducing the unit cost to as little as 60 F per person. However this implies an overall investment of some 175 KF.

2.1.2.3. Reception/Terminal Equipment

Multimedia Workstations

The market for multi media workstations is expected by some analysts to reach 10.3 billion Ecu per annum by 1994. This breaks down into three main use areas - business presentations (4.4 billion by 1994); information retrieval (3.4 billion) education and training (2.5 billion). Multimedia workstations will vary in price form the $ 1.000 quoted for a CD-I player to $ 25.000 for the current IBM compatible DVI.

Technical configuration for multimedia are expected to be as follows:

1. Compact Disc interactive (CD-I) - aimed at the home user and consisting of a CD-I player (compatible with domestic CD players), domestic television, CD-I software and CD image library. Philips and Sony have established the CD-I standard and will inevitably be market leaders. CD-I is expected to retail at around 1.000 Ecu in the coming two years. Intels DVI based system is currently 25.000 Ecu but prices could fall quickly.

2. Apple systems - based on Apple standards, hypercard software and third party peripherals, aimed at the home and business user.

3. Intel's Digital Video Interactive - based on the DVI chip, IBM software and microchannel architecture, video cards, compressed video library (compact disc) and artificial intelligence software. Olivetti has created a joint venture with Intel to convert DVI to European standards and to integrate Intel's DVI board into Olivetti computers, equipped with CD Rom drives.

4. NeXT's multimedia workstation incorporating a magneto-optical disc drive, and voice annotation of text.

5. Hewlett Packard's New Wave workstations integrating video, audio and still images

6. SUN and equivalent workstations - expected to upgrade existing workstations to incorporate moving video. SUN is now researching a workstation which will use high definition images.

Personal Computers

Growth in the personal computer market in Europe is now heavily dependent on decisions made in educational faculties. Most secondary schools in Europe have now standardised on 16 bit PCs, from an initial installed base of 8 bit. More powerful machines based on RIS chips are being introduced, such as the Archimedes. Student and faculty spending accounted for 35 - 40% of the home PC market in Europe in 1988.

In some Member States the growth of the Home Market is a significant development. In Denmark for example a drive by IBM, the major supplier in Denmark, to maintain and increase its dominant market position led to a round of discounting to price sensitive users such as small businesses and home users. Intense competition in the PC market following the slow-down in sales in the USA has brought a round of price reductions in Europe led by American suppliers. The educational sector in particular has been a major beneficiary..

Equipment in the Home

Many of the components necessary for interactive education in the home are already available. A problem for the long term development of Flexible training and education delivered to the home is the lack of standardisation even in emerging technologies. For example the choice of incompatible transmitting standards by satellite TV channels, and different signal encryption methods, which have already fragmented the market for satellite TV programmes.

TV reception is a low cost method of receiving educational material. Most homes are now equipped with televisions and an increasing proportion will be able to receive via satellite reception dishes and cable television networks.

Current TV Penetration in the Community

	%
Belgium/Luxembourg	95
Denmark	96
France	98
Germany	97
Ireland	94
Italy	94
Netherlands	97
Portugal	85
Spain	96
UK	98

Figures not available for Greece

Source: OECD 1987 and J. Tydeman European Market Forecasts for Cable, SMATV and DTH 1987 - 1996

Growth of Ownership of Video Cassette Recorders as a % of TV Owning Homes

	1979 %	1987 %
Belgium/Luxembourg	1	22
Denmark	1	32
France	0	33
Germany	1	39
Ireland	1	50
Italy	0	5
Netherlands	1	1
Portugal	0	9
Spain	0	13
UK	1	58
Belgium	2	34

Figures not available for Greece

Source: J. Tydeman and Financial Times Media Intelligence Unit

Expected Growth of Satellite TV Reception

Based on reception via satellite receiver dishes, SMATV systems and cable networks it is estimated that 45 million homes will be receiving satellite transmissions by 1996.

2.1.3. Requirements and Options

Much of the infrastructure for the reception of training material in the home and in business already exists in the form of TV sets, video cassette recorders and TV reception equipment. PCs are increasingly penetrating the home and small business markets.

However, new products with far greater capabilities and which are well suited to educational use are now coming on to the market. In particular CD-I, DVI and multimedia workstations offer the learner the ability to interact with learning materials.

It is important that these products are adopted by trainers, and that they fall within the buying range of small businesses and home users. It is expected that, in the case of CD-I, this will happen in the near future.

In order to maximise the benefits of R & D it is essential to identify the critical cost factors. These appear to be: the cost of powerful multimedia workstations for authoring and simulation, the cost of multimedia production and the cost of telecommunications transmission. However these factors and possible cost saving need to be better understood.

Digitisation of the telecommunications infrastructure and the introduction of ISDN present the possibility of more extensive interaction 'at a distance'. Costs, however are high for the end user. Some form of educational discounting scheme is necessary.

Producing multimedia products is expensive largely because of the costs of sourcing moving images and advanced graphics. Cost reductions in this process are essential. This is particularly important because of the introduction of HDTV in the near future. The quality of images is improving dramatically. Trainers and educationalists could be forced to operate at quality levels which are unacceptable to the average use unless advances are made in production techniques.

The long term technical goal should be to provide training on demand via electronic networks.

1. It is necessary to have a better understanding of critical cost factors in multimedia production. This can only be done by examining real life situations. The process is complicated by the rapid rate of innovation. An understanding of new technologies and their potential impact on the cost of learning systems is essential.

2. Low cost forms of distribution such as MVDS appear to be given a low priority by PTAs, yet they offer a distribution outlet for local training and education which is proven to be effective in the United States. The potential for using MVDS for training and education should be examined.

3. Critical cost areas such as the production and compilation of high quality images need also to be examined. This is a priority research and application area.

4. An educational television service has already been proposed by the European Round Tables Educational and Training Working Group. Such a service will need considerable technical support if it is to adopt new technologies such as HDTV or if it is to engage in interactive services.

5. The long term goal should be to provide training on demand via electronic networks. However this implies considerable investment and pre-implementation pilots.

2.2. SPECIAL INTEREST GROUPS

2.2.1. Statement of the Issue

Training services must be directed at special interest groups if the objectives of the single market and of Social Europe are to be realised. It cannot be assumed that special interest groups are an attractive market for entrepreneurs. Special interest groups which may be neglected in the process of technological advance include handicapped people and the rural and peripheral areas.

2.2.2. Description, Status and Trends

People with Disabilities

Advances in learning technology, whilst undoubtedly of general benefit, can intensify the isolation of people with disabilities. Systems which depend on a combination of enhanced vision and sound, especially those operating through the telecommunications network can make simple communications devices such as the telephone more difficult to use. Complex access numbers for computer conferencing present difficulties to the blind, as does videoconferencing. Normal use of telephones is already difficult for people with physical impairments. Interactive systems generally assume full tactile, oral and visual proficiency.

Multimedia systems can be designed in such a way that disability if taken into account. An over reliance on visual cues for example could be avoided by incorporating sound cues, and vice versa.

In Europe as many as 15% of the population have hearing difficulties, the largest proportion in the over 60s age group. The average incidence of blindness is 2%. However in Spain, for example, it is estimated that as many as 32.5% of the population are in need of optical correction. 2% of Europeans have several difficulties either with comprehension or speech. 6% have difficulties in walking, 3% have difficulty in lifting or pushing and 2% have problems with manipulation.

These figures indicate that advances in learning technology must take account, first of all, of various levels of disability and that secondly people with disabilities constitute an important target group for user friendly learning systems.

Some progress has already been made in adapting telecommunications equipment to the needs of disabled people, al of which are relevant to new learning technology - sound amplification, text telephones where a message is typed and received as type, larger keyboards, braille displays, concept keyboards.

2.2.3. Requirements and Options

Advances necessary to accommodate the needs of people with disabilities are complex and wide ranging. Although people with disabilities constitute a significant proportion of potential users, their needs are so varied that they cannot be considered as one homogeneous market for hardware and software producers.

The following technical needs for new learning systems are of particular note:

'Writing telephones' are important to people with severe speaking and hearing problems. The writing telephone consists of an electronic pen with which messages can be written and transmitted. Adapted keyboards with icons for use in complex messaging codes. Text to speech synthesizers. Scanning devices for automatic dialling. Communication by pictograms.

However these technologies will only be incorporated into learning systems if there is a general political will to ensure that the benefits of advanced learning technology are extended to all groups.

The learning needs of people with disabilities may not be served, and may actually be frustrated by technological advance. People with disabilities constitute a significant proportion of the European population but their needs are unlikely to be met through market forces alone. Action and funding at the European level is necessary.

2.3. RURAL AREAS AS A SPECIAL NEEDS GROUP

2.3.1. Statement of the Issue

Rural areas are extremely important for the future prosperity of the Community. The development of IT+T could be a significant factor in a number of economic strategies: in the process of encouraging resettlement by highly productive firms; in improving efficiency in agriculture; improving efficiency in local manufacturing and in promoting tourism.

2.3.2. Description, Status and Trends

An analysis of European population distribution reveals a surprising statistic - Europe is still a predominantly rural continent with approx. 150 million people living in rural areas that is 57% of Europe's population. There are over 80 million people living in areas where population density is 64 people per square kilometre or less. The population of these 'very rural' areas compares with just over 21 million people living in 'very urban' areas (1,164 persons per square kilometre) or respectively 30% as against 8% of the population.

Average population density in Europe is 132 inhabitants per square kilometre. Very rural and rural (153 inhabitants per square kilometre) areas account for 86 % of the land surface of the Community.

Rural areas in Europe produce a significantly lower share of Gross Domestic Product per head of the population than urban areas:

The average GDP per head of population in very rural areas is 9,468 Ecu per annum compared to 20,489 per head in very urban areas. Within rural areas there are also wide divergences. The lowest GDP per head in very rural areas is 2,406 Ecu; the highest is 16,148 per head. Total GDP for very rural areas represents only 20% of total GDP even though almost a third of the European population live in very rural areas.

The statistics demonstrate the importance of rural areas and the under development of productive capacity in the majority of land settlements in Europe.

Training is a big problem, especially training to help rural areas cope with and exploit IT+T.

A study commissioned by DGXIII looked at rural needs in Norfolk, in the UK, Donegal in the Republic of Ireland, and Foggia, in Italy.

In rural Norfolk IT+T was seen as vital to competitiveness - in particular the need for network digitisation was quoted as an prerequisite for attracting subsidiary plant of large companies who inevitably would want high quality links with their Head Quarters.

"Training (in Norfolk) is considered extremely important for the successful adoption of new technologies. However although employers realise the importance of training they are still reluctant to invest vast sums of money into training their employees".

The study of Donegal showed 30% functionally illiteracy. IT+T there, is being held back due to the low level of education. The community was resistant to change. There were difficulties in finding computer literate teachers. There was little to hold graduates in the countryside.

In Foggia there is a different approach to IT+T and different results. In Foggia the 1990s were described as the age of the computer. Farmers regard computers as an administrative and financial aid. Demand for computers is increasing at 20 times the rate of five years ago.

2.3.3. Requirements and Options

Rural areas represent an enormous market for training and education. However, cultural as well as technological factors impede the development of new training services based on advanced technologies. Both of these barriers must be overcome.

IT+T skills, and a more intensive use of IT+T in rural areas, could improve productivity and could improve the quality of life, making rural areas more attractive. At present rural ares are a massively underdeveloped resource in Europe.

The long term option for rural and peripheral areas is for a level of supply and equipment which is comparable with urban areas. An interim option is the electronic village hall or 'telecottage'.

In Scandinavian countries a number of rural telematics experiments are taking place. Telematic equipment and services are being provided in rural areas in local village halls. These are nov commonly referred to as telecottages or electronic village halls.

The electronic village hall is typically equipped with all the element of advanced IT+T. In principle the village halls concept allows people in rural areas to become familiar with IT+T whilst being under no external pressure to 'train' in its use. This process may be described as 'acculturation'-helping to introduce rural areas to the IT+T culture.

3. LEARNING TECHNOLOGY PEDAGOGICS

3.1. EDUCATIONAL STRATEGIES OF ADVANCED LEARNING TECHNOLOGIES

3.1.1. Tutoring the Learning Process

3.1.1.1. Statement of the Issue

Successful applications of distance/open learning depend on the availability of sufficient and effective learning support for the learners to allow them use and harness learning environments and the learning process independently. The support should be self-directing according to the individual learners' profiles in their homes, corporation/enterprise, or institution. For example "help programs", computer coaching, facilities for local adaptation of learning materials and, facilities for the provision of human support through networking fall under this category.

However tutoring is not only associated with computer based training. Human tutoring supplemented by advanced learning technology tools in a local learning or training centre or at a distance by 'hot phone' lines, teleconferencing, etc... must be taken into account. In research studies and literature on advanced learning technology too little emphasis is given to these more 'traditional' tutoring possibilities.

3.1.1.2. Description, Status and Trends

With increasing use of advanced technology learning systems are more likely to be isolated from fellow learners and from their tutors.

Tutoring the learner and the learning process is one of the most crucial aspects. To tutor successfully requires a general capacity to adapt to the individual learner together with skills in using a variety of media. This communication can be two-way tutor-student interaction via telephone, face-to-face, or by more advanced means like teleconferencing. However tutoring is often only used in an indirect way through an one-way communication between tutor and learner or, alternatively, through more advanced developments whereby the tutor is embedded in the system, eg Intelligent Tutoring Systems(ITS).

The way tutor and student are communicate or interact depends on the scheme of education which is used:

Centre-based Scheme

Tutor-learner contact is frequent but brief. Oral discussion or work possible.

Local Scheme

Less frequent face-to-face contact; possibly none at all. Other communication methods become important especially letter, telephone, teleconferencing, etc.

Distance Scheme

Very rare face-to-face contact or none at all. Other communication means become vital; important to enlist local agents for 'support' where possible. Often the support must be given by stand-alone tutoring systems (Computer assistance or intelligent systems). However, the human tutor can, through audio, video and teleconferencing (one-way or two-way), stay in direct contact with the learner or a group of learners on distance.

The majority of distance education systems use print materials as the principal medium for teaching and tutoring. Also, in systems where print is combined with other media, it is often the principal carrier of the course content, with the other media supplementing and re-inforcing the materials.

A recent Commonwealth-wide survey shows for example that of 306 distance learning institutions, 86% use text-based materials, 53% use audiocassettes, 38% telephone teaching and the same percentage use video. 27% mention the use of computers, 14% the use of radio and 9% the use of television. In addition the institutions indicate other learning methods such as practical work, study centres, residential schools and kits.

However many distance flexible education and training institutions already use advanced information and communications technologies for tutoring where infrastructures and costs allow. A Canadian survey showed that in a sample of 66 distance institutions, 46% already used satellite and 43% cable systems for distribution and interaction facilities; 31% report the use of television; 7% the use of radio; 74% the use of audioconferencing and 34% the use of computers.

Radio is used as a means of broadcasting educational material to the general public and as a means of allowing interaction between students undertaking formal courses and their teachers. Interactive educational programs are offered on broadcast radio by means of talk-back via telephone and teleconferencing. The advantages of using this technology are that it is relatively inexpensive, flexible, portable and widely used.

At present a number of drawbacks are associated with the use of radio, whether used for broadcasting only or for interaction:

- students preferred radio-vision to radio
- students were generally unable to use broadcasts to pace their studies
- radio was the first component omitted when a student was pressed for study time
- the use of audio-visual channels combined with a help line are superior to radio plus written notes.

Like radio, television is familiar to everyone and readily available to most. Its potential to deliver educational material to large audiences and, when supplemented by telephone technology, also to improve interaction, has been recognized for some time. One-way television used with terrestrial telephone to allow students to call in to the broadcast is called interactive broadcast. Still diagrams, pictures, printed documents and other graphics can be transmitted by means of slow scan television. This technology is a useful supplement to telephone conferencing but at present is only used in an experimental way for example at the Open Learning Agency - the Audiographics Project (Vancouver- Canada).

Audio, video-, and computer conferencing: The use of audioconferencing is increasingly gaining importance in distance teaching, in particular in decentralized systems which operate through a network of learning centres. This is evident in projects in Indonesia, the West-Indies, the South Pacific and Peru but these methods are also applied at the Knowledge Network and Contact North/Contact Nord. The Knowledge Network is connecting multiple sites by the OPTEL system through the KN's teleconferencing bridge in Vancouver. This technology allows simultaneous transmission of text, graphics and voice between multiple points.

Two-way video and audio interaction by satellite is not cost-effective enough to be used particularly often in education but training large amounts of trainees on a distance, for example in Ford Motor Company and Open Learning Agency, increases the potential for this technology.

Audio- and Video teleconferencing, audiographics and computer communications are applied at the Knowledge Network to provide audio & video tutorials from the students homes and local learning and enterprise centres.

Computer based tutoring is applied in a stand-alone situation where no human tutor is available. Computer based tutoring can support learner-directed learning rather than system (or tutor) directed learning and provide an important counter balance to more didactic learning materials.

Computer Based educational applications have been under development for roughly three decades. Most widely named as computer-assisted instruction (CAI), these applications attempt to instigate and control learning. The traditional tutoring programmes have been successfully in a limited number of domains under very specific conditions. Currently there is a tendency to improve their presentation capabilities by using advanced devices such as videodiscs and CD-ROMs. In addition more freedom is being allowed to the learner browsing in a hyper-media based programme. All these technologies allow the user to engage in a kind of educational dialogue, albeit with very limited capabilities, on the site of the system.

When compared to human teachers, CAI programmes show shortcomings: they do not contain knowledge about the domain they are teaching and thus neither justify their behaviour nor respond to questions; the author must anticipate all possible learner responses: the lack of domain knowledge prevents the programmes from reasoning about learner misconceptions.

A new role of the computer in the didactic process was outlined by Cognitive Science studies and in particular by S. Papert contributions on Learner environments. At this stage AI techniques were used to develop Intelligent CAI (ICAI), where teaching procedures were separated from course material. These systems incorporate knowledge about tutoring techniques, the course domain, the learner and the learner/tutor dialogue. This explicit knowledge facilitates the implementation of reasoning techniques about the previously mentioned entities involved in these instructional systems.

Hence, recent ICAI, also called Intelligent Tutoring Systems (ITS), aim at providing instruction that can adapt itself to the learner's need, capacity and desired style of learning and optimize the courses for each learner. The most important feature incorporated into ITS is the capability of individualising the instruction.

The goal of ITS can only be realized using techniques already developed in AI, in particular:

- making explicit the knowledge about the course domain
- making explicit the knowledge about didactics
- allowing the program to reason about the domains
- allowing the program to reason about the learner.

Current research and development in advanced tutoring systems concern particularly the feasibility, adequacy and efficiency of architectural design choices in the different concrete teaching/learning situations. So far, many prototypical ITSs have been built and a few products have also been concretely experimented, evaluated and used.

It is possible to give an approximate classification of such systems by means of a spectrum which represents the degree of control on the interaction with the learner that the system exhibits:

--- -- - degree of control by the system + ++ +++

user driven mixed initiative tutor driven

At the left end of the spectrum we find learning environments and more precisely the systems for learning by discovery and systems for learning-by-doing. In the first case the learner explores the environment without guidance by the system, which is activated only on requests by the learner. In the second case, by facilitating learning-by-doing there is often also an attempt to combine the problem solving experience of the learner with the effective guidance typical to tutorial interactions

At the right end of the spectrum we can find programmes in which the system has the complete control over each step of the interaction. In the most advanced systems, the strategy of teaching is generated during run time and adaptive to a more or less complex qualitative learner model which is constructed and updated during the dialogue.

In the middle of the spectrum we find the mixed-initiative systems in which the control alternates between the learner and the system. This has the task of monitoring the learner during each step of the interaction and to provide him with advice not only when he makes a mistake, but also when he makes an inquiry or asks for more explanation about an issue that was not clear during a previous presentation.

Occurring problems in ICAI are:

- the technology used in the classroom is rapidly falling behind that of the workplace
- most learning materials have had little or no pedagogical design; only 3% of educational software have been written in the context of an articulated pedagogic rationale
- nearly all commercial courseware treats all learners as identical
- traditional courseware designs are hard to modify
- ICAI has in the main been done by AI scientists with little, if any, involvement with educational technology specialists, classroom instructors or very many learner users
- no field testing or evaluation of ICAI programs in realistic classrooms

As an example of recent developments in the domain of ITS we can examine the 'Exploring Systems Earth' and the 'glass box' approach approaches.

The Exploring Systems Earth consortium is an USA-wide network of universities and research organizations developing and exchanging new ITS'. ESE creates three new ICAI approaches: integration of appropriate features of each of the existing paradigms with emphasis on building a misconception-based learner model; leadership roles for end users in the design and development process ; and large scale classroom dissemination and testing as part of the formative evaluation. They integrate hypermedia (including text, videodisc and digital audio), manipulable simulations, animation, graphic overlays, remote sensing, problem solving skills tutors and other CAI and ITS technologies. Misconception is a central part of their program: software should stimulate user exploration of the domain and offer sufficient flexibility to create lessons that are individually unique and instructor modifiable.

Another example is that of The Institute of Research on Learning in San Francisco, developed under the auspices of Xerox PARC and Hewlett Packard. IRL is using its expertise in AI and its understanding of learning to look at the educative potential of computers in an entirely new way. Through their work on several innovative systems (Buggy, West, Sophie and Guidon) researchers now at IRL pioneered many of the crucial features for successful intelligent tutoring systems.

This work made it quite clear that it is wholly inadequate for instructional technology to consist of just animated textbooks, elaborate chalkboards or automated didactic teachers. IRL's research shows for instance how well-designed technology can engender the rich process of reflective learning, collaborative and explorative learning and apprenticeship learning. Systems designed as resources to foster such learning are currently under development by researchers at IRL. These include systems to help people learn Newtonian physics, mathematical functions and medical diagnosis as well as an environment for instructional design and an entire reconstructible computational medium. All contribute to the development of IRL's new theory of "glass boxes", a theory about learning and technology.

Information Technology brings new dimensions to the glass-box concept, eg

- simulation of highly complex or safe-critical systems free of physical limitations
- audio-visual animation in combination with simulation based on graphics and video technology
- dynamic explanation that help the user to construct an interpretation of processes in terms of functional, causal and structural relations.
- flexible interaction through a model of the user.

At present in IRL researchers on intelligent tutoring systems have started to explore the possibility that computational systems may construct and use such models. In fact, in the process of designing sophisticated interactive instructional systems, IRL started to explore all the dimensions mentioned above (like projects as Sophie and Guidon concerning simulation, animation and explanation; projects such as Buggy and West explored learner modelling and pedagogical deliberation. Most of these issues are now pursued in Guidon2 and other current IRL projects). Though very relevant to building glass-box systems, this type of technology was developed for systems whose purpose is solely educational. In contrast more traditional AI applications such as expert systems and smart job aids have provided tools for accomplishing specific tasks without attention to inherent educational opportunities. The glass-box concept is an attempt to merge the two an integrated environment. Beyond the goal of producing useful and user-friendly systems AI technology is then taken to promise systems that help users help themselves.

In spite of all the accomplishments and the remaining challenges at the technological level investigating the glass-box concept is not primarily a technological endeavour. The glass-box concept points to a new type of system - one able to respond to the fact that the user's knowledge evolves in order to propose and accept new levels of interactions. IRL is paving the way for a new type of knowledge engineering, which merges traditional knowledge engineering with educational design by explicitly taking into account the fact that learning is a central part of interaction with systems. This type of engineering views design as a process of continuous renewal. This has a fundamental impact on cognitive and pedagogic issues and research. Glass-box systems as educational systems have to be viewed as part of an embedding world in which learning actually takes place (group learning, distributed learning). All these research issues along with the technological questions are all currently pursued within IRL.

3.1.1.3. Requirements and Options

1. More work must be done on the development of cognitive and pedagogical guidelines underlying tools and systems to assist in the tutoring of the learning process.

2. The technical approach should be incremental starting with construction of relatively simple tutoring models and progressively leading towards

3. More emphasis must be given to new applications of traditional tutoring scenario's such as the provision of human tutoring through networking, one-way and two-way tutoring facilities in distance education. Although those tutoring scenario's were nearly not subject of research, they are the most often used in practice.

Emphasis must be given to developments for

- lecture-based courses using cable, satellite or video based technology supplemented by set reading. Further research is needed on elaborating real-time two-way communication means between tutor and learner (only if required) like audio-video-conferencing, audiographics.

- electronic courses using the telephone and electronic communications based primarily on interaction between tutors and students on a regular and on-going basis. View-data systems (videotex) must be further developed as useful media for interactive teaching by combined use of telephone and TV.

4. Developments in the area of Intelligent Tutoring Systems are desirable in order to provide teacher support in a stand-alone situation or assisting the human tutor in a local environment for highly specialised subject matters. Specific requirements are as follows:

- It is desirable to provide adaptive tutoring. In other words, the tutoring could be tailored to the user's expectations or needs, and be compatible with the knowledge level of the user. Therefore the intelligent tutor system must compile comprehensive information regarding the evolution of the learner's work and how he/she progresses in the learning process.The importance of adaptive feedback for the achievement level and motivation are also clearly well known through research.

- Towards that end, the system should be cooperative in interacting with the user. This can be compared with a partner role. Hence, as its most important objective, the system will help the user formulate his/her queries to make his/her intentions explicit and possibly adapt its responses according to the user.

- The system should allow for mixed initiative, in other words, even if the system can initiate the conversation and conduct it according to a global plan it should make allowances for the user's initiative and requests for clarification, changing subject and style of dialogue. This will be realized through active/passive modes of the tutoring dialogue. In passive tutoring mode the system guides the user. In the active tutoring mode the user is actively engaged with the system and his interests drive the tutorial dialogue.

- The system's 'attitude' should be to motivate the learner to play an active role in learning, e.g. be more eager to put forward questions and try to explore the system and consolidate what s/he has learned so far.

- The system might incorporate mechanisms that facilitate predicting the intentions of the user to supply the user with additional or informative explanation.

- Finally, the system must ensure that the user is never stuck, i.e. the system should provide alternatives that will avoid a dead-end or act as a short circuit in order to continue with the tutoring process (smooth degradation). For example if no knowledge sources are available about a subject, the system might suggest a human tutor that the user can consult.

- In addition to supporting individual learners such a system must be designed to support cooperative learners working in groups (either local or widely distributed).

5. Working on designs that encourage learners to experiment freely, developing their own learning strategy.

6. Knowledge acquisition and knowledge representation work is underdeveloped within the domain of ITS. In particular, the acquisition of the knowledge needed to instruct or train has specific problems and constraints. More research is required on the critical features required in knowledge elicitation tools and into the exploration of possible design decisions.

7. Research to identify misconceptions that most commonly emerge during tutorials.

8. To facilitate through intelligent support systems the use of interaction environments for learner-to-learner and learner-to-tutor communications, using electronic networking and remote access to multimedia and distributed data and information bases.

3.1.2. Help and Support of the Learning Process

3.1.2.1. Statement of the Issue

The technology of help and support systems is devoted to supporting the use of specific devices or tools. In particular a 'help system' which is activated upon a user's request to instruct him how he can continue operating the system from the point he arrived at. Help systems act only upon user's request.

To beginners, the usefulness of help systems is usually limited because of the value of their instructions can only be appreciated by advanced learners. In this sense, they are to be contrasted with tutoring systems, which mainly address the instruction of novice users and in a mode controlled by the tutoring system. Both kinds of system are obviously related, because they address the instruction of the user of a device. In fact, a help system can be seen as a prolongation of a tutoring system, since it carries on giving support to the user after the training phase has finished.

3.1.2.2. Description, Status and Trends

Help systems have been subject of a large evolution since early mainframe system times. Today we can identify three main categories:

1. Traditional ones.
2. Systems relying on new concepts and possibilities from Hypertext media
3. Systems based on AI that can try to give some kind of 'intelligent' support to the learner as a human consultant could.

Traditional Help

The simplest kind of traditional Help System consists of a specific command of the software being used ("help", "h", "?", ...). This command gives access to an electronic book representing a reduced version of the paper manuals.

The user can search for information either through consulting the entire manual or by using an index. Anyway, it is always up to him to find the information needed. A first enhancement to this type of interaction has been a contextual access to the contents of on-line manuals. Usually the learner can issue advice requests not only about a particular demand (as an example the "man" feature in the UNIX operating system) but also about objects, components and functions of the system. For instance within a Word Processor you can request information about different parts of the "editing window" or about printing documents.

With the arrival of more sophisticated computer interfaces (graphics, windows, menus, mice, tablets) the power of context-dependent advice grows by allowing the user to issue requests more easily by entering a "help state" through an appropriate command, and then pointing at items to be explained by the Help System.

Another evolution within traditional Help Systems has been towards increasing the quality of the advice given. The contextual level has been transposed from commands to be used, without handling difficulties in syntactical and semantic aspects, to problems that need solving with sequences of commands not completely known to the user, or to error situations that must be debugged. In other words, an evolution towards Intelligent Help Systems.

Hypertextual Help

It is widely felt that hypertext systems offer great promise for implementing effective help systems. The introduction of commercial hypertext/hypermedia systems such as Guide and Hypercard on PCs, and more sophisticated environments on workstation, has led to a brand new way of supplying on-line help to application software. Some producers have chosen to bundle their products with Hypercard Stacks or Guide Documents that constitute both a tutorial and a reference about the software application.

Usually these types of help are not well integrated with the programs because they are built with separate systems and in environments that usually do not contemplate multitask processing. Anyway the conceptual power of the Hypertext links and the powerful programming capabilities of Hypercard generally encompass this inconvenience, letting the learner access information in a non-guided, non-linear way but still following his needs.

Within a Hypertext system, information can be organized very differently from a traditional database. The information units become small chunks, sometimes called frames, made up of text, graphics, sounds, etc Between such frames links can be established by the author of the database. These allow the user to navigate through the information exploring some concepts explained by a frame with all the related concepts, explained by the frames linked to frmae in use.

The main advantage of this approach is that it focuses only on things of interest and hides the superfluous. But it is also easier to get lost in such information systems because of the greater number of paths that can be followed through existing links.

3.1.2.3. Requirements and Options

Intelligent Help Systems are the new trend to help the student or trainee to use information retrieval systems, word processing packages, etc. For a help system to be described as intelligent it should have the following capabilities;

Question answering and explanations: One function of a help system must be to answer a variety of user questions and to explain its answers, which requires that it has at least a comprehensive representation of the application domain.

Advice giving/coaching: Answering 'What should I do now?' questions require not only a representation of domain knowledge but also some understanding of how to undertake and plan tasks. The system may offer unsolicited advice that can be better termed coaching.

Adapting to individuals: One of the greatest criticisms of conventional help systems is that they do not take into account the level of the user and what he is attempting to do. So an intelligent help system has to adapt to the background knowledge and experience of the learner and the current context.

Learning/self optimization: An intelligent help system might be expected to refine its performance in the light of experiences with the learner.

New developments in Intelligent help systems are directed mainly towards domain independence, hence leading to the construction of Intelligent Help System Shells. In this stage, they encounter one of the main problems of AI: the fact that the more general the approaches and techniques employed are, the weaker the result in terms of general computational inefficiencies and/or infeasibility. The application of 'ad hoc' techniques for a particular domain seems to give better results with Intelligent Help Systems.

3.1.3. Monitoring and Management of the Learning Process

3.1.3.1. Statement of the Issue

The management of technology based learning requires an effective system for transmitting information, to a diverse range of actors including students, tutors, counsellors, course developers, administrators and researchers. Each actor has different information needs, for example;

- students need to receive regular guidance on their learning progress, and to be informed of administrative procedures relating to their registration, progress, assessment etc.
- tutors need to be informed of problems in students'learning.
- course designers require feedback on the effectiveness of courseware.
- administrators need access to student records.
- researchers require data on the characteristics of the student population, together with details of students' progress, and data for course evaluation.

An information management system is an essential tool for certain actors in the system, ie tutors. It can provide the information needed to make decisions, it can advise which course has to be followed and it can facilitate accreditation and certification of courses. Tutoring and monitoring are of course very related. Monitoring however is a process which takes place over a range of different courses and very often involves more than one student.

3.1.3.2. Description, Status and Trends

Nowadays Advanced Learning Technologies are mostly used as a supplement to other educational aids where the human teacher and trainer has the role of managing the learning process. However as has been proved at Ford Motor Company it is more effective to bring the learner back into the workplace and assist his learning by coaching and tools which advise on quality of performance.

Studies of existing systems have highlighted the complex nature of this task. The need for accuracy and fast turnaround of information, together with the quantity of information involved, creates pressures on conventional systems.

Even where computerised systems have been used, problems have resulted from the inadequate integration of the needs the system is required to meet and the various actors within the computer based management system. These are compounded by the slow turnaround of information from tutors and other actors in the system. The underlying pedagogical and instructional strategies have to take into account the different views of different actors on the same data.

3.1.3.3. Requirements and Options

1. Designing and developing the shell of a knowledge-based system to inform a future expert monitor or course manager at different stages of understanding during the course process.

2. Development of monitoring systems which provide high level, adaptive help to the learner; which automatically create and deliver timely reports to human tutors; and which provide assistance and advice to both learner and tutor, especially in regard to choice and use of instructional strategies.

3. The technical approach should be incremental, starting with construction of relatively simple monitoring models and progressively leading towards the development of sophisticated and adaptive systems.

4. A possible approach is the development of facilities for the interactive monitoring of the pupils' work. This should be such that it is RAM resident and compatible with all other programmes and able to provide an electronics blackboard emulation. Similarly, it is possible for pupils to 'pass the chalk' and annotate the screen in the view of all their peers. The tutor/monitor can supervise any one learner's activity at any time and freeze or take over the system if desired.

3.1.4. Modelling the Learner or Trainee

3.1.4.1. Statement of the Issue

Learner modelling concerns the 'model' of the learner that is present in the system, and that can be used to adapt the systems actions of appearance to the user. This will help the learner by making the course more personalised.

In order to select appropriate learning/instructional strategies which are best suited and adapted to the needs of each individual learner, it is necessary to have information on relevant learner characteristics in the form of a learner model.

3.1.4.2. Description, Status and Trends

This information or model will then be used for monitoring and tutoring facilities, for example to guide the choice of media and courseware, and the nature of interaction and help available to the learner.

Ohlson introduced the expression 'cognitive interpretation' to substitute the more commonly used term 'learner modelling'. It indicates that a model is not the only possible representation of the knowledge acquired by the learner, and that the objective of this component of a tutoring system is to use the information about the learner to determine a didactic strategy.

Four different information types required for cognitive interpretation can be identified :

- What can the learner do?
- What does the learner know?
- What kind of learner is examined?
- What has the learner done so far?

The first question aims at individualising the procedural knowledge of the learner in the given domain, the second at finding which domain facts the learner knows. The last two concern the observation of the learner's behaviour and the third an evaluation of this behaviour. To answer these questions the learner model must contain various types of information: the conceptual and procedural knowledge of the learner, its individual features and the history of the dialogue. In current tutoring systems this information is either not completely present or represented in ad hoc forms.

The range of applications for which user models may be used, and the different types of contents they may contain, indicate that a variety of user models can exist.

The types of user models themselves can be classified according to a number of dimensions.

- models for individual users and models for classes of users

- static or dynamic models:
  models specified explicitly either by the system designer or by the users themselves versus models inferred by the system on the basis of the users' behaviour. A learner model can attempt to model the learner's mental capabilities as they change dynamically during the course of learning. This type of modelling, which is a desired feature of intelligent tutoring systems, has been described as cognitive diagnosis.

- models of fairly long-term user characteristics, such as areas of interests versus models of short-term user characteristics eg the problem the user is currently trying to solve.

- descriptive or prescriptive models.
  The descriptive model is simply a database of information about the user. Prescriptive use of a user model involves letting the model simulate the user for the benefit of the system.

The contents of user models can be a hierarchy of goals and plans reflecting the learning history, current learning state as well as future learning plans; mental and physical capabilities; attitudes as well as knowledge and belief.

The following four theories of user modelling are commonly applied.

(i) The first theoretical model implies a description of the learner through numerical parameters describing the learner's skill to respond correctly to the questions posed. This type of model only gives an approximate quantification of the learner's knowledge and supports the didactic decisions only at a global level, eg. increase or decrease the level of complexity.

(ii) An overlay model specifies which proportion and thereby, indirectly, which knowledge units the users still needs to learn.

(iii) A bug model or error description adds information about what might be called negative subject matter.

(iv) Finally simulations enable us to make detailed predictions about the performance of the user.

The most spectacular progress in user modelling in the past years is the appearance of computerized diagnostic methods for identifying the errors of individual users. Such methods have so far been successful in a small number of knowledge domains, most notably arithmetic, algebra and elementary programming or control of automatic systems. Most of these domains can be described in terms of clear rules or simple procedural knowledge.

The inferential procedure which is used in this type of diagnosis is based on an error library or a list of possible errors. Given a particular user, it is possible to compute which error (or combination of errors) best accounts for the incorrect answers of the user. The basic difficulties are (i) to establish the error library, which is a labour-intensive undertaking and (ii) to invent methods which can compute the best-fitting error combination efficiently enough to deliver a diagnosis in a reasonable time.

The pedagogical promise of an error description is that it might enable remedial instruction. However deciding on the best remedy for a particular error is not a trivial matter and in fact error descriptions have not been used in many tutoring systems.

The error description methodology has serious limitations: it is inexact, incomplete because there is no practical way to catalogue all possible bads for any complex system and inflexible because bad plans can not be detected unless they are included explicitly in the catalogue.

In summary the fundamental principles of cognitive interpretation models are (Vigorelli, 1987):

- corrective, to help the system eliminate errors in the learner's knowledge;
- elaborative, to help the system extend the learner's knowledge which may be correct but incomplete;
- strategical, to allow the system to change its didactic strategy in order to be more learner-adaptive;

- diagnostic, to urge the system to initiate a dialogue which eliminates ambiguity with the learner;
- evaluative, to verify the real knowledge of the learner.

3.1.4.3. Requirements and Options

Learner modelling is regarded as a crucial aspect in flexible learning systems. However, learner modelling can also be regarded as one of the most difficult enterprises. There is more than one reason for this.

1. Learners differ in may respects and thus learner modelling has to involve a number of different issues such as information about general learner characteristics versus information about the progress of the learner as he interacts with the flexible learning system.

2. It is necessary to establish a relevant set of taxonomies to describe the learner in the open and distance learning and education context. The taxonomies should be based on the main dimensions of importance to learning (cognitive, psychomotor, socio-affective, behavioural, cultural, linguistic).

3. Specification of methods to allow classification of different types of learners and to describe typical learners and variables is another requirement.

4. Another aspect of learner modelling is the level 'of generality of the model, which determines the grade of adaptability of the system to the learner. Should user models refer to the average learner or to the individual learner or take an intermediate approach aiming at classes of learners (Gargan et al, 1988) with the use of stereotypes?

5. Ideally the model of the learner, and the learner characteristics and behavioural attributes, should be dynamically constructed and adapted in response to the learner's behaviour and interaction during the learning process.

6. The development of dynamic learner models will allow optimisation of adaptive learning materials particularly in the facilitation of learning through immediate appropriate feedback. However the construction of such dynamic models is rather costly and is only cost-effective for highly specialised skills which cannot be trained by traditional means or basic skill training for large audience.

7. Learner models can be used for different aims : corrective, elaborative, strategic, diagnostic and predictive. Each poses its own specific requirements for the learner model.

3.1.5. Didactic Strategies for Learning by Means of Advanced Learning Technology

3.1.5.1. Statement of the Issue

The term didactic strategy refers to the choice of instructional methods and media designed to bring about effective learning. This includes not only the 'content' of the course but also decisions about learner support, assessment and choice of media.

3.1.5.2. Description, Status and Trends

Determining a didactic strategy involves

- specifying the level of knowledge, skills and understanding that it is assumed the intended learner population or individual learners will already possess;
- specifying the overall aims and objectives of the course in terms of the content, the 'learning domains' and the level to be attained. The learning domains can be conveniently specified in the 'aims' of the course, and the levels reached in different topics indicated in the list of objectives;
- analysis of the contents in terms of learning domains;
- deciding on the instructional methods and media, including appropriate learner activities (such as practical work). These must be appropriate to both the learning domains and the resources available;
- determining the form of assessment (if required) for the purpose of judging whether the intended aims and objectives have been achieved.

Flexible and distance learning has always been a method for education and training which has emphasized the efforts of individuals working alone with varying degrees of contact with expert tutors, supported by structured learning materials. Two methodologies ("generations") have evolved: (i) correspondence courses using the postal system and (ii) correspondence courses exploiting broadcast (radio and television) systems as well as the postal system. Radio communication has permitted more live interaction between students and their human tutors in many areas of the world.

Newer methods of interaction are becoming increasingly common. It is clear that a third generation of flexible and distance learning systems is evolving. This third generation is characterized by exploitation of the New Information Technologies such as satellite broadcasting, computer conferencing, advanced telecommunications and multimedia computer based training systems. Many initiatives in this area have been taken at European, national and regional levels. For example the European Association of Distance teaching Universities (EADTU), EUROPACE, PLUTO, etc... The Commission of European Communities has also launched several R&D programmes like Comett II, DELTA, Eurotecnet, etc...

Those new methods of teaching and learning in a more distant and flexible way evoked new means of instructional strategies. The scope has beenbeen broadened in the sense that a demand has arisen for more learner controlled instructional strategies like exploratory learning, simulations of dynamic environments, collaborative learning and embedded training.

The process of following different didactic strategies, sometimes also called 'learning scenario's' (Cerri & Sanangelo, 1988), (Yazdani, 1986) can be split down into sub-issues:

- human tutoring situations,
- intelligent tutoring systems,
- exploratory and simulation environments,
- collaborative learning.

3.1.5.3. Requirements and Options

1. The methodologies required in a flexible and distance learning should reflect the modes used by learners when engaged in independent study. In addition, they should be complemented by the availability of a variety of instructional styles. More research is needed to determine which instructional style fits with which different learning mode and in which learning situation each is most efficient. It is therefore, the development of technologies to support such flexible and diverse tuition systems which must be emphasized.

2. Strategies to encourage learning by doing are one of the most demanded approaches in didactic theory. ALT by means of creating interactive models for simulations and exploratory learning allow the real achievements of such a paradigm.

3. Open and distance learners differ from other types of learners in several respects. Therefore courses and systems must include adaptive learner models.

4. The DELTA environment should support all kind of instructional strategies and it should be possible for these strategies to operate on the same type of multi-media data. In addition some combination of knowledge base approach of ITS and the explorative style of learning environments maybe fruitful.

5. Implementation of the advanced technologies cannot proceed cost effectively without thorough testing, prototyping and experimental trials of the integrated technologies in a variety of environments. These must represent clear regional, sectoral, local or specialised training and re-training needs. Through pilot applications the full impact of flexible and distance learning on a Pan-European level can be evaluated. In an iterative and incremental way this will permit the building of a coherent paradigm of pedagogics of flexible and distance learning.

6. The infrastructure of flexible and distance learning courses is still centrally controlled and tied to traditional pedagogic structures. More effort is needed on the development of a European-wide education and training system based on distributed communications.

3.1.6. Human Tutoring Scenarios

3.1.6.1. Statement of the Issue

In Human tutoring scenarios (the most commonly used) advanced learning tools supplement and re-enforcre more traditional learning tools like books, audio and video, etc. The human tutor is tutoring and managing the learning process locally or on distance.

3.1.6.2. Description, Status and Trends

Data from the UNI/ICDL database show that print is still the principal medium used (91%) in the majority of distance-education programmes but only a small minority of the programmes (9%) rely exclusively on print; secondly by far the most popular technical medium after print is audio-cassette (appearing in 44% of the programmes) and thirdly a significant proportion of programmes use relatively costly media: television (15%), video-cassettes (21%) and kits of material for practical work (18%).

In the situation in which a computer programme is used as an aid and not as a substitute for traditional training, the teacher or trainer has the role of managing the learning process.

In fact Computer Assisted Learning nowadays plays an important role together with other educational aids (eg. connected with a video projector, with software of presentation, video-graphic communication in the traditional training process). It implies a saving of cost and time.

Before the course starts CAI can be used to choose the teaching contents according to learner needs and after the course to evaluate the learning outcomes.

3.1.6.3. Requirements and Options

1. Emphasis must be given to the development of learning technologies which can be used in a integrated and educational effective way by a human tutor in a local learning situation (learning or training centre, classroom, etc...) or on distance. These developments can be rather low technology tools eg multimedia presentation tools, item banking, testing tools or they can be highly sophisticated like interactive videoconferencing.

2. It is important to study the different didactic strategies which can be implied by a human tutor and which have a multimedia integrated approach.

3. Analysis of specific needs of special categories of disadvantaged learners which overcome by means of Advanced Learning technology

3.1.7. Intelligent Tutoring Strategies

3.1.7.1. Statement of the Issue

Very often in a distant learning situation the tutor is embedded in the computer-based system. As a consequence tutoring and monitoring facilities must be fully embedded within the system and adapted to the learner's individual needs (Intelligent Tutoring Systems). Off-line help in the form of hot-phonelines and learner centre assistance stay necessary.

3.1.7.2. Description, Status and Trends

Intelligent Tutoring Strategies are only used in isolated subject domains and are in a phase of experimentation.

The different didactic strategies used in Intelligent Tutoring Systems are:

- In the case of **Socratic dialogue**, the system poses questions and presents situations by which the learner is driven to recognize the inconsistencies in his/her own reasoning.

- Another learning scenario consists of **reactive environments**. They allow the learner to solve problems without intervening. Only when the learner asks, does the system help or explain the current state of the problem. The system only reacts to a formal question for further learning advice or help on a specific topic. This philosophy is used in SOPHIE 1, 2 and 3.

- In the case of **rote learning**, the tutoring system intervenes actively to facilitate the learning process. This approach is used by GUIDON, which trains the learner in medical case diagnosis. At the end, the learner's solution is compared with the solution of the expert, which in the case of GUIDON is provided by the expert system MYCIN.

- The scenario of **learning while doing** requires a tutoring system to be incorporated into the operative environment. The system intervenes when the environment user asks intervention; e.g. the user gets stuck. EUROHELF is an example of such a system.

3.1.7.3. Requirements and Options

Early approaches to CBT which were used in defined types of applications as drill or rote and tutorials, were based on the principles of 'programmed instruction', varying from purely sequential material to fairly complex branching structures.

Considering the current state-of-the-art in both instructional technology and software technology (specially IKBS techniques), neither simple nor complex branching structures are sufficient. A new paradigm is required.

1. Technology has to engender the rich process of reflective learning, collaborative and explorative learning and apprenticeship learning. Intelligent systems to foster such learning must be further developed. Questions like how and how much should the learner control their own progress through the material need to be considered. Learner control can be a key to effective learning.

2. Traditional AI applications such as expert systems and smart job aids have provided tools for accomplishing specific tasks without attention to inherent educational opportunities. This aspect of education must be taken more into account in AI and ITS developments. A further requirement is the development of a new type of knowledge engineering which merges traditional knowledge engineering with educational design.

3. ITS' have to be developed which respond to the fact that the learner's knowledge evolves in order to propose and accept new levels of interactions.

4. ITS' as educational systems have to be viewed as part of an embedding world in which learning actually takes place.

3.1.8. Explorative and Simulated Scenarios

3.1.8.1. Statement of the Issue

Explorative environments are considered to be an alternative for ITS. They do not try to guide the learner towards some predefined cognitive state. They offer a stimulating environment to be explored by the learner. This exploration is expected to augment the learner's experiences, and hence also his/her level of knowledge.

Computer-based simulations are other explorative learning environments. Strategies to encourage learning by doing are one of the most demanded approaches in current didactic theories.

3.1.8.2. Description, Status and Trends

One of the more promising approaches is based on the notion of *exploratory learning of microworlds*. In such flexible learning systems the learner is much more active than in conventional tutorial types of teaching. The control in such an environment is completely left to the user.

However the benefits are not without shortcomings. On the one hand this approach avoids the problem of having, formalising, representing and using a theory of learning and a didactic strategy. On the other, the user is often not able to fully explore his/her environments without hints from the system. Therefore some combination of the knowledge base approach of ITS and the explorative style of learning environments may be fruitful. This leads to another line of research called Guided Discovery Tutoring.

The best known learning environment is without doubt the language LOGO which was developed originally as an instrument to teach mathematics to children. With LOGO, Papert developed and proposed the notion of "microworld" as a general solution for the problem of motivation in an educational environment (Papert, 1985, 1987). Papert observed that a child's capability to learn new concepts increased, by the method of discovery presented within LOGO's microworld. He also concluded that this concept could be generalized and that microworlds describing physical phenomena could be used for didactic purposes.

Computer *simulations* are used in many contexts, such as what-if-analysis, experimentation, and education. Instructional use of computer simulations has four characteristics;

- presence of a formalised, manipulable model
- presence of learning objectives like knowledge of principles, knowledge of procedures and knowledge of acquisition skills
- the elicitation of specific learning processes such as hypothesis generation and testing
- presence of learner activity. Learners can perform manipulate situations through the model.

The application of simulations in education is important for a number of reasons, of which probably the most important is that learners will be engaged in active exploration and learning, an approach which is advocated in instructional/ learning theories. In this respect computer simulations are different from general courseware because they are not aimed at substituting the individual, experienced teacher but offer new teaching opportunities.

Creating hypotheses or changing time scales in simulations might sustain this learning approach. Additional reasons for using simulations are, amongst others, the possibility to create situations that are unacceptable in reality eg for reasons of danger, costs or time. Providing real time symbolic representations of the different variables involved in a model will help the understanding of the most complex concepts.

Learning through exploration puts high cognitive demands on learners. This may result in non-efficient and non-effective learning behaviour, where students will start floundering and groping and do not use the opportunities the simulation environment offers. Guidance and support must be given if learning from simulations is to be effective.

Therefore in order to be effective, simulations require the presence of an instructor to monitor the performance of the student and to provide guidance, help and explanations.

Ideally in an open learning situation where the learner is separated from the human tutor, this would mean embedding the simulation into an adaptive learning environment, capable of functioning in the above respects as a human tutor. The state of the art is that most simulations are used in a learning centre or on distance with the assistance of a human tutor (by 'hot phone' lines, audioconferencing etc.)

In general, learning with a computer simulation is characterized as learning in an explorative environment. Such an environment stimulates the application of certain processes such as problem solving, discovery learning, explorative learning, inductive learning.

The following multi-layered table describes the different learning processes in a simulation environment.

General	....	*Detail*
level 1	level 2	level 3
Orientation	observation	collecting retrieving
	analysis	encoding structuring combining
	model explanation	
Hypothesis generation	focus	*no further division*
	design hypothesis	integrating generalising
Test	design exp. prediction manipulation interpretation	*no further division*
Evaluation	observation generalisation	*no further division*

At present several DELTA projects are working on simulations embedded in intelligent learning environments. They are engaged in the definition of the requirements and specifications for an authoring environment for such

3.1.8.3. Requirements and Options

1. Emphasis on further research how technological advances and different didactic strategies can increase the effectiveness an learning process of explorative environments.

2. Exploratory learning and simulation based training requires the integration of several types of flexible learning.and some coaching (or guidance) of the learner is needed. This requires sophisticated systems which can do learner-modelling etc. and efficient methods and tools to develop them.

3. It is required to integrate hypermedia methods within exploratory environments. Hypermedia-based materials cover all kinds of interrelated information sources through which the learner can navigate (in microworlds) in order to explore the huge amounts of information contained by these sources. Hypermedia-based training is becoming widely used for flexible learning but the learning aspects are still relatively unexplored eg the authoring process for structuring high amounts of information into a useful learning system.

4. In general we can say that not much is known about the effect of instruction and support on the learning process and the resulting gain of knowledge. Guidance included in exploratory systems mostly has an eclectic character and no evaluation of the different forms of instruction and support is made. Qualitative evaluation should be encouraged in order to assess the outcomes of the different ways of coaching learners.

5. It is still unclear what kind of models should be offered to the learner in the simulation in order to achieve a certain learning goal.

6. How the process of learning within exploratory learning environments takes place is still largely unknown. Experimental research in this domain is sparse. A better insight into the learning processes that occur in exploratory learning environments are crucial. A comparison between successful and unsuccessful learners might furnish data on which guidelines for instruction and support could be given.

7. There is a shift towards the use of simulations for carrying out highly specialised tasks (like managing a firm, providing medical or psychological diagnoses,) which are considered to be a highly complex form of a problem solving task. The situation in which the act has to take place is complex (the information is abundant, highly amorphous and unstructured), non-transparent and autodynamic (the situation changes without the actors interference). More research is needed in this domain.

8. Simulation-based training requires the integration of several types of flexible learning (simulation is not sufficient in itself, it must be combined with other forms of instruction like coaching).

9. Development of prototypes are required to allow experimental research on learning and the development of techniques for evaluating learning with an ISLE.

10. Development methodology for designing simulations with clear prescriptive guidelines about when to use what instruction and support, with which models and for what type of learners.

11. Testing and assessment of simulation tools in real educational situations for the learning of complex and safety-critical systems and processes.

3.1.9. Collaborative Learning

3.1.9.1. Statement of the Issue

Collaborative learning at a distance is one way to overcome the isolated situation of the distant learner. By collaborative learning is meant learning in a group whereby the different actors are communicating with each other at a distance.

3.1.9.2. Description, Status and Trends

Until now there has been only little systematic investigation into social interchange between learners at a distance. However, a few studies have been carried out which enlighten the advantages of collaborative distance learning like higher efficiency and quality, cost reduction, higher learning effect and reduction of learning time.

The importance of peer learning, coaching, tutoring and monitoring among the learners themselves in the mode of self-directed (mastery or competency learning) shows that, by electronic networking and remote access to multimedia and distributed data and information bases it is possible to use the advantages of tuition by peer coaching and avoid its disadvantages by means of advanced information technology.

Collaborative open and distance learning requires high levels of connectivity. These can be accomplished via terrestrial networks, or direct broadcasting satellites.

3.1.9.3. Requirements and Options

1. Needs analysis of the technological requirements (ISDN facilities, digital transmission of high definition television and/or high speed data transmission) for two way communications for collaborative learning. These may be of three general forms in addition to the broadcast form of reception: person to person; person to group; group to group.

2.Research on the relevance of particular communications and networking technologies to particular learning objectives.

3. Adaptation and implementation of RACE and DELTA developments on specific communications facilities for the needs of collaborative learning in home, corporate, institutional, regional and sectoral environments as well as specific adaptations to special needs.

4.Development of open and distance learning methodologies and advanced information and telecommunications systems which positively encourage different actors like learners, authors, tutors to interact with each other.

5.Subsequent research on how authors and tutors are instructing learner classes. This is closely related to learner attributes such as IQ, learning skills including reading, note-taking, organisation of material; metacognitive skills including reflection, analogy, transfer; confidence, etc

6.Development of collaborative and distributed learning application pilots which positively encourage different actors like learners, authors and tutors to interact with each other through Advanced Information and Telecommunications Systems.

3.1.10. Psychological, Motivational and Human Factors in Flexible and Distant Learning

3.1.10.1. Statement of the Issue

The basic approach of human factors research in flexible and distant learning is to examine the relationship between user characteristics and pedagogic demand with regard to what technology has to offer. In particular it is the user characteristics versus technological offer relation (also called human-machine interaction) which presents the difficulty in developing appropriate technological specifications. The choices to be made between Advanced Leaning Technology offers for satisfying user characteristics/pedagogic demand needs are comparatively easy but only if the user characteristics/technological offers relationship is determined.

It is necessary to bear in mind that the relationship with a computer is more often than not in some way 'cool' with the consequential psychological and even unconscious resistance.

3.1.10.2. Description, Status and Trends

The psychological aspects of a multimedia and interoperable environment can be presented by a five layer model adopted by the International Standards Organization (ISO), which has implications for technological considerations at every level of realisation and architecture.

1. The Sensory Motor level: is concerned with the input devices available to the user which enable him/her to communicate with the computer. Reviews of the major categories of input device are considered from a user perspective viz keyboards; mice; light pens; touch screens; trackballs; joysticks and graphic tablets. The comparative studies which have been carried out indicate that although the QWERTY keyboard is not the fastest form of inputting device it is an accurate one.

2. The Perceptual level: is concerned with the structure of information presented on the screen. A fundamental issue is the determination of the amount of information which may be effectively presented on the screen. The empirical evidence suggests that as a rule only the minimum amount of information required for task completion should be presented. Consideration is given to the importance of highlighting techniques such as: reverse video, colour, brightness, underlining and 'flashing'. The most pertinent issue in the adoption of such techniques is that they should be designed with the semantic content of the information being presented in mind. Inappropriate use of such techniques will interfere with the cognitive performance of the user as their task will be more difficult. Other key perceptual issues considered are the surface structures of text, graphic functionalities and windowing techniques.

3. The Interface level or Dialogue level: focuses on the way the interface is structured from a user perspective. Various forms of interface dialogue are considered: commands, menus, query languages, direct manipulation and intelligent interfaces. For the design of a command name set it is the goal to develop a set of names which can be easily learned for, as yet, no ideal way has been established to develop a command name set.

The key issues of menu design are the descriptors for each option and the ordering of these option and menu navigation. The consideration of menus extends into a consideration of direct manipulation interfaces with particular regard to information presentation and input devices, invoking functions and user perceptions.

4. The Application level: is concerned with issues of pedagogic style which affect the effectiveness of the learning invention for the learner. This level can be viewed from three perspectives, the domain, the technological and the learner.

In a domain perspective the ALT developer produces a solution to a pedagogic problem in a clearly delineated domain and attempts to generalize the approach to any other domain.

In the technological perspective, the ALT developer decides on a particular technological solution to a pedagogic problem and applies this solution often without considering the likely impact of alternative technologies. In the ALT environment a number of learning and tutoring tools have become available most notably in the form of knowledge based systems, simulation systems and exploratory environments a la Papert (1980).

In the learner perspective the ALT developer focuses on the communicative needs of the learning situation and the pedagogic requirements of the tutor and the trainee. In order to be effective to understanding the requirements of the application layer must include a consideration of the different psychological demands which a task makes on the individual (see Miller (1967); Gagne (1970)) in conjunction with knowledge of the nature of human learning. This approach is regarded as being the most informative, because it can provide recommendations as to the appropriateness of the various methodological tools available.

5. The Curriculum layer: the overarching layer of the Human Computer Interaction. Emphasis on the pedagogic intervention is taken away from the human pedagogue and given to the technology.

Another important factor is the extent to which the social nature of the pedagogical interaction is diminished in the ALT environment. This isolation can eliminate the tension which can originate from comparison with others. At the same time all the positive aspects of group work will be lacking, such as exchange of experiences and the chance of learning from other learners' questions. Social interaction between instructor pedagogue and other learners acts as a positive motivating force.

3.1.10.3. Requirements and Options

1. The human machine Interaction Layer model is as yet incomplete. Two different approaches are possible.

The first approach is to build within the OSI model in terms of increasingly more user-oriented features. This would result in a hierarchy of levels above the current application layer which would connect user and organization level descriptions at the top to bit stream transmission at the bottom. At present this view of the model has not been developed to any degree of specificity.

Another approach is to develop a separate model of human computer interaction. This is to be achieved by taking the ISO formulation as a conceptual framework to guide and discipline activities. In this way a model of the user in the human-machine interaction process is developed.

Given the current status of the technology the first ISO approach is a very long term view, the second is more feasible in the short time. But, in adopting the ISO formulation as a conceptual framework within which user considerations are investigated, the model will be able to contribute to the ISO model if such developments occur.

2. It has often been remarked that for the naive user, the interface *is* the program. Thus, correct decisions at low levels in the hierarchy of the model will turn out to have an inordinately large effect on the acceptance of any system. Key elements are interoperability and re-useability. Therefore many low-level decisions will perforce be a compromise between what is demanded from the higher levels and what is realistically available.

Moving to the higher levels, there is the difficulty with many of the advanced learner systems that the knowledge is represented in the form of expert understanding rather than as a suitable guide for instruction. There is thus a need for an intermediate level of abstraction of this knowledge so it is appropriately presented for instructional purposes.

3. Since the interface is an important concern, it is argued that emphasis on intelligent interfaces is appropriate for ALT. This style of interface will overcome presentation difficulties with low technology media. Moreover, the user model has to be explicitly using this type of technology, rather than implicitly as for example in the direct manipulation type of environment. This is an advantage for purposes of interoperability between groups of users with different pedagogic requirements and characteristics. In this way, intelligent interfaces support interoperability over both hardware and user type.

4. Too many ALT solutions have been influenced by technology and technological achievement. A more appropriate starting point is the learner perspective and an analysis of the learning task. This option has two consequences: (i) the system developer can no longer hide behind an appeal to a particular technology as a solution to a pedagogic problem in the requirement specification, and (ii) the prototypical ALT application must include not only a knowledge of the domain but also knowledge of the learner.

Specific Problems and Constraints

The Sensory Motor level: The major problems with many of the empirical evaluations of these input devices to date is that they have been too specific, relevant to only one or two tasks.

The Interface level: should have maximum interoperability, bearing in mind the necessary constraints of the learning task and the intended user model.

The Application level: An important issue here is the importance of evaluation in instructional design programmes viz the extent to which knowledge is transferred to the learner.

The domain specific as well as the technological perspective suffers from the same problems. The tools developed to date have been specific to small subsets of their domains. A tutoring system exemplifying a single pedagogical method can never be sufficient to deal with all learning situations. Each unique learning environment and each learner brings to the learning interaction a set of capabilities and requirements.

What seems to be missing from many of these technologies is a clear statement of the educational objectives as can be found in SOPHIE. Also lacking is a clear set of evaluation criteria to demonstrate their effectiveness.

The Curriculum layer: There is a danger in the ALT environment that attention will be focused on the structure of the material rather than the content.
One of the difficulties which ALT environments suffer from is the inability to perceive the motivational level of the learner and the subsequent failure to respond accordingly.

Emphasis in the pedagogical intervention is taken away from the human pedagogue and given to the technology. The extent to which this will be beneficial or otherwise is determined by the nature of the learner and the nature of the task to be learned.

Related Requirements

For many users the distinction between the interface and the application is blurred. and as such the choice of lower level characteristics is vital if a climate of acceptance is to be generated for ALT use.

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3.2. DEMONSTRATING LEARNING TECHNOLOGY EFFECTIVENESS

3.2.1. Statement of the Issue

Demonstrating the effectiveness of learning technology is an important issue for the its uptake and real penetration into the market.

The effectiveness of learning technology depends on the suitabiltiy and adequacy of the media and learning strategies to the topic and to the learner patterns. Learning materials must be flexible enough to allow self-pacing, access to complementary resources, choice of level of difficulty and give appropriate guidance within pedagogical resources.

3.2.2. Description, Status and Trends

Effectiveness of learning technology applications have been evaluated according to several methods:

- the measurement of the **time taken to acquire** certain knowledge/skills (and in comparison with conventional methods). Initial tests have shown that it takes less time to acquire knowledge using new technologies.
- the measurement of **retention rates** for knowledge/skills over different time periods. The same tests have demonstrated that the retention rate was less effective when using new technologies.
- the measurement of **costs of traditional** versus Learning Technology based **methods**.

These methods provide valuable results when they are used for comparing traditional approaches and technology-based approaches to learning processes in the same content areas. But they fail when technology addresses new kinds of learning processes for instance in the cognitive and the psychomotor domain such as:

1 Learning by doing
Information and image processing provide better insights of some fields of knowledge than textbooks and verbal explanation have been able to do so far. They allow the student to explore models and play with parameters within those models.

2. Problem solving in interactive environments
Through interactive environments, it is possible, for example in a management course, to explore the consequences of different decisions. A learner can be asked to provide the solution to a problem in chemistry, and according to its answers, measures of its decisions would be represented on the screen: colours might change, an explosion might be simulated. Physics provides examples of such interactive environments.

3. Autonomous and collaborative working
Evaluations carried out in United Kingdom have demonstrated that "The educational value of distance education in the sense of personality development, widening of consciousness and promotion of autonomous learning ... can be considerable if full use is made of the potential inherent to this kind of education." Collaborative working has been given a new dimension by the use of networks and teleconferencing. Stand-alone configurations can also favour working in groups if courseware is used as a tool in a global approach involving common actions.

These new teaching possibilities have been enabled by the emergence of developments in technology and therefore are not comparable to any form of traditional teaching. They must be evaluated in their own right the criteria being the improved quality of the learning, for instance measured by the level of understanding or improved ability of the learner to perform certain tasks. Effectiveness of the use of learning technology in these areas is then shown by the changed behaviour of the learner. Methodologies to measure the impact of training by learning technology packages need to be developed.

3.2.3. Requirements and Options

1. Catalogues of good practices
The use of learning technology has proved effective both in overcoming bottle-necks in training provision in specific areas and as a way of training personnel in specific fields. Examples of such successful applications of learning technology should be made available to a larger audience in order to stimulate others to integrate technology in the appropriate segments of their training schemes. Some such work has already been carried out by the Commission and it should be continued in order to demonstrate the diversity of uses of technology in education.

2. Identification of technology
Further work should be carried out into the identification of available technologies, according to the needs and learning processes. It seems that studies on relevance of technology to the specific knowledges and skills to be taught are neglected. Moreover, 'systematisation' in this domain is risky since pedagogical styles are involved and complementary approaches are required.

3. Technology based assessment tools
Technology based assessment tools should be provided. Such tools could be aimed at facilitating distant guidance of students who want to register on courses. They could also be used for certification.

4. Experiments and pilot applications are important because learning technologies, when successful, are only one component of a complex learning system. In respect to new teaching contexts, it becomes difficult to carry out the evaluation of one element independently of the system. Pilot applications remedy this difficulty as they provide a way to test different complex combinations of media. Test-beds should be organised with groups and users from different sectors. DELTA could call on Community programmes such as EUROTECNET, COMETT and LINGUA, in order to carry out such experiments and test methods in concrete training situations. This approach would create a favourable climate for the effective take-up and evaluation of advanced learning technology. It would help establish mechanisms for the effective exploitation of the results of DELTA.

3.3. EVALUATING COSTS OF LEARNING TECHNOLOGIES

3.3.1. Statement of the Issue

The reduction in costs of software and equipment and the cost effectiveness of new ways of training compared with traditional methods are key issues for the acceptance of learning technologies. Many potential users cannot afford the materials at the current prices.

3.3.2. Description, Status and Trends

A comparison of costs, based on the resources used, has been carried out in the following areas;

- development costs
- execution costs
- costs of learning materials
- user infrastructure costs
- access and communication costs

The results tend to demonstrate that technologies are **cost effective** when dealing with **fast changing knowledge** versus slower changing, and **matters which are skills-based** rather than knowledge (such as mathematics) or culture based.

More obviously, when dealing with courses for which **costs** can be **offset by a large number of trainees** and when development of **infrastructure** may be **paid off through a large number of products**, learning technologies prove to be inexpensive.

Access and communication costs are in practice higher for the traditional courses than is generally realised, eg one third of university course attendance cost can be attributed to access and communication. For companies this factor can account for about half of total course costs, when hotel and travel expenses are included. The costs of learning technologies are considerably lower, and estimated at 10-50% of direct learning costs.

Most of the comparison of costs are based on models which demonstrate the critical level of users necessary in order to pay for the costs of developmental infrastructures. The difficulty is to obtain an accurate estimate of the minimum costs and number needed before investment of money in "automated" ways of learning (educational software and video) in the workplace or at home becomes viable.

It is very difficult to estimate the costs of development of interactive media. The only statement, which can be made and which is confirmed by existing practice, is that: the more interactivity or more 'intelligent interaction' a learning multimedia product has, the more costly it will be.

The B.I.P.E. (Bureau d'Informations et de Prévisions Economiques) has compared the costs of traditional training and the costs of using multi-media materials to arrive at estimates of the costs of the different media. These are rough estimations based on case studies. We cannot extrapolate from them, but we can obtain an idea of the state of the art in cost evaluation methods.

- paper learning materials,
30 ecus per page is given as an average cost for producing a paper brochure for a multimedia training.

- interactive video,
3,000 ecus per minute of video is given as an average cost.

- **courseware,**

Estimates for courseware development on computers vary from 5,000 ecus per hour for a module of 20 hours on the economic and social environment to 20,000 ecus per hour for a module of 50 hours on driving automated equipments. This is the cost of processing. In the case of interactive video, it does not include the cost of the video images. The topic itself is not so decisive in the price ranking. More important is the scenario which has been chosen and the possibilities of object processing (interaction with words, sounds, graphics, sentences, symbols).

- **audio,**

1,500 ecus is given as average for one hour of audio material.

In its study, BIPE considers those costs as 'mediatisation costs' to which need to be added:
- the costs of implementation,
- the costs of test,
- the costs of diffusion.

The BIPE has made an attempt to compare the costs of multi-media learning and traditional learning according to five hypothetical case trainingsituations:

CASE 1 - Training sessions in order to present the applications of new technologies to industry (robots, micro-electronics)
CASE 2 - Training sessions to present the applications of new technologies in offices (desk-top publishing, wordprocessing, filing systems)
CASE 3 - Training in operating flexible manufacturing systems
CASE 4 - In-house training sessions in management and accountancy
CASE 5 - Remedial teaching.

The five case studies are based on average data which are deduced from market surveys. As the market is still limited, these may be questioned. Nevertheless, the study does not aim to give a synthesis of all existing situations. It indicates that each concrete situation is specific, and that parameters should be specified in each case.

For each example case, BIPE set an hypothetical number of packages to be produced and an hypothetical number of hours of teaching (length of video + length of audio). Then they deduce an average cost for each hypothetical package.

We must bear in mind that multimedia products run on hardware configurations which involve computers, video recorders, audio recorders (eventually) and paper materials.

The costs for the different types of learning in this comparative analysis are:

	implementation	mediatisation	test	diffusion
Case 1: 20 hours 500 packages	75.000	500.000	15.000	100.000
Case 2: 50 hours 2.000 packages	75.000	500.000	7.000	110.000
Case 3: 50 hours 200 packages	80.000	2.000.000	40.000	30.000
Case 4: 21 hours 1.000 packages	30.000	300.000	15.000	160.000
Case 5: 10 hours 5.000 packages	10.000	75.000	7.000	220.000

The conclusions are the following:

	The student's hour cost **traditional training**	The student's hour cost **multi-media training** if	
		one user	10 users
Case 1 (new technologies in industry)	45 Ecus	120 Ecus	34 Ecus
Case 2 (new technologies in offices	50 Ecus	32 Ecus	21 Ecus
Case 3 (Operating manufacturing systems)	no estimation given the specificity of using learning technology		
Case 4 (management and in-training sessions)	70 Ecus	65 Ecus	40 Ecus
Case 5 (remedial teaching)	16 Ecus	26 Ecus	7 Ecus

The implicit assumptions leading to these conclusions are as follows;

- For each specific form of training, the cost of one hour of traditional training depends on the cost of students time, cost of trainers time and all overhead costs.
- The cost of tutoring and the cost of students time are taken into account in the different scenarios.
- Indirect costs such as travel time and the differences in wages due to the target populations can be isolated.

- The depreciation of equipment, specifically dedicated to training, is also taken into account.
- The following other assumptions have been made in the study to compare traditional training costs and multimedia training costs: it has assumed that there is a balance of the duration of training between multi-media interactive training and traditional training ; it has assumed that there is an initial cost for multi-media interactive training which makes it valuable if there are a number of students to pay off those initial costs.

As with most studies of this kind, it can be demonstrated that multimedia training costs are, in many cases, higher than traditional training.

Elements, such as the choice of topics, style of the multi-media environment and the context of training, should probably be more precisely taken into account.

Others costs should also be priced in the near future:
- **telelearning** by video links, supported by telephone or electronic mail. This could (be costly but) become a key issue for motivating users and helping them when the system is failing.
- **videotex information** which can help bridge the gap between the demand of the user and the supply by remote training materials producers.

3.3.3. Requirements and Options

1. Research on tariffs and costs
The production of guidelines and criteria by which Advanced Learning Technology costs and benefits can be identified, described, quantified and evaluated within a common framework is urgently needed.

Studies must be made not only to investigate existing levels of equipment, but to investigate the market niche for equipment and the price sensitivity of the different categories of potential users.

As an outcome of such work, it would be possible to produce and disseminate a framework document containing guidelines and criteria for identifying, quantifying and evaluating Advanced Learning Technology costs and benefits. The document could be produced in a format designed for widespread dissemination to Advanced Learning Technology users and providers.

2. Standard facilities
- The issue of costs is tightly related to the question of lowering production costs.
- Facilities for rapid prototyping, authoring tools must be investigated.
- Some of those tools can help lower the prices of products, by providing a common software lay for courseware developed in different disciplinary areas.
- Facilities for courseware translation would also lower the costs in providing a better access to the European market.

3. Information on prices and costs analysis
The problem of choosing the media to be used in education gives rise to another requirement, the availability of adequate information on the suitability of different systems for different learning environments, including related costs.

The factors which contribute to Advanced Learning Technology costs may be defined and categorised in relation to a range of different education and training needs. These definitions will include comparisons of the development costs of tailored open learning programmes and generic packages. Access and distribution costs, hardware, software and specialist support may be included if relevant.

Comparisons of **communication costs** should be carried out in order to compare services and costs provided by videotex information services, electronic mail, teleconferences, etc.

4. Real situation assessments using testbeds
Cost/benefit analysis from pilot Advanced Learning Technology projects will be an important contribution. Benefits from pilot Advanced Learning Technology applications will be identified, described and evaluated. It is important to compare the development costs of courseware, when using different authoring and production environments. This has to be done in real situations.

The cost of different production environments and delivery systems should be assessed. Alternative approaches should be tested to ascertain whether open materials are customised in order to fit different teaching situations or whether generic products are produced. For example, it is costly to develop a spreadsheet, but it meets a great deal of diverse needs and users.

3.4. EVALUATING PROCESSES AND SKILLS

3.4.1. Statement of the Issue

New technologies must improve the efficiency of the learning process. They must also facilitate transfer of skills, possibly taking into account the learners' pace and style, and technological potential. Few evaluations have been carried out so far.

Evaluation of the learning process itself is a key issue in so far as it allows the adaptation to style, pace and presentation. Keeping track of the learner reactions is one of the aspects of tutoring and monitoring systems, and broad evaluation of processes must be carried out in order to improve the interactivity and user friendliness of all systems.

There is also a requirement to evaluate those sectors and disciplines in which learning technology appear to be particularly relevant and appropriate. This is an issue which has been particularly emphasized by all actors in the field of commerce and industry, and in the field of small and medium enterprises (SMEs).

3.4.2. Description, Status and Trends

A first review of this problem led DELTA to the conclusion that learning technology is relevant for skills or knowledge transfers in the following cases:

- for transfer to remote, isolated or underdeveloped areas,
- in dangerous or expensive learning environments, such as nuclear plants or aircraft maintenance,
- when a large number of people need to be trained in a short time,
- in areas where training potential is dispersed and scarce.

Early studies in DELTA also show that learning technology can be used successfully in areas distinguished by the nature of the skills and knowledge which is to be taught. According to this distinction it is feasible to use learning technology when:

- graphical representation is relevant,
- the different parameters of a lesson can be expressed in a model which a learner will be able to understand and play with,
- the knowledge appears like a puzzle from which one can express the different components, and act - with the help of the computer - as a synthesizer.
- the computer can command a sequence of images, film or an audio sequence as an illustration to a definition.

There is now growing consensus that learning systems should not focus on fact teaching, but should help learners to build their own knowledge architecture. In this respect, emphasis is put less on solutions (good/bad, true/false) than on the process of problem solving (OECD, 1987).

Whatever skill or knowledge is taught, **motivation** is a key issue. In the domain of pedagogics it is essential to maintain the interests of the learner throughout the process. Relevance of knowledge representation, information structuring, timing and screen design play a key role. Film, photograph, synthesis image, graphics, audio cassette will have different impacts on making a topic lively, giving accurate representations.

New "structured visual information" such as spreadsheets, filing systems, textprocessors, adventure games and relational databases will have still another effect on cognitive processes. Those new tools affect the way we handle and store information and transfer it to knowledge, and so far their consequences have not been assessed.

3.4.3. Requirements and Options

1. The self-assessment techniques.
The new technologies are primarily used as formative tools. However they fail for the most part to meet the requirements of assessment. Assessment which offers learners support, develops their motivation and assists them in developing their studies is still mainly provided through written, or face to face communication with tutors.

2. Research into the cognitive skills used to handle the new media, as compared to traditional ones.
- What is specific to the process of writing by word processor compared with traditional handwriting?
- What is specific to paper filing compared with electronic files and data bases processing?
- What processes are involved in "desk top representations", adventure games, simulations?
- How could technology itself help to carry out such evaluations?

3. The identification of learners and producers.
There is a requirement for a better knowledge about the consumers and the producers. In particular an analysis of the motivation and abilities of both potential learners and providers is needed. Part of this identification has been done during the exploratory phase of DELTA. It should now be consolidated, with a greater emphasis on relevant sectors for training and for production of learning materials.

4. The identification of skills.
Skills for which traditional training approaches are inadequate, too dangerous, ineffective or costly should be identified.
For example, use of computers is particularly relevant in two aspects:
- routine or repetitive information on which computers can propose drill and practice to the learners,
- complex environments, such as flight simulations, for which the computer can offer simple models.

Video is particularly relevant for skills which involve physical behaviour and gestures, or for training diagnostic skills which involve visual detection of faults or anomalies. Such skills should be identified in order to stimulate the production of adequate products for training.

5. Process assessment.
There is a need to shift the attention from evaluation of products to evaluation of the process of learning itself. Research in this area would involve studies of error-making (why and how students get things wrong). Artificial intelligence techniques could be used here. Methodologies to detect errors must build on domain specific research.

3.5. EVALUATING RESOURCES

3.5.1. Statement of the Issue

One of the main difficulties in extending experiments and using learning technology in education arises from the inability to evaluate the quality of courseware.

3.5.2. Description, Status and Trends

How to Evaluate Software Quality?

Many teachers, developers, trainers have raised this issue, which partly condition financial investment in new products. The trends we describe hereafter are based on evaluation of the quality of software for schools and not training systems, but the situation in training courseware evaluation is comparable.

A first trend is based on a **peer evaluation of software**, a sort of consumer testbed, which has been experimented with since 1982. A group of evaluators is asked to make comments and then each one outline its criteria and the group looks for consensus. This approach was adopted by teachers' associations like MICROSIFT in United States (Microcomputer Software and Information for Teachers) and INRS (Institut National de la Recherche Scientifique) in Quebec. Critics of this method argued that consensus was reached on purely formal criteria or ideological consensus, and this would guarantee neither the success of a product within the user environment nor eventual success with children.

Another criticism, in distance education related to the fact that the experts estimated the learning video materials, without concern for the feedback mechanisms between the learner and the tutorwhich will be installed eventually , in order to improve or balance the content of the materials with complementary tools. Group evaluation has, in some cases, led to the involvement of the institutions in charge of the courseware delivery.

A second trend relies more strongly on **consumer questionnaires**. Users of educational products are paid for answering long and complex questionnaires, whose contents are formalised by EPIE Institute (Educational Product Information Exchange).

There are questions about **implementation and use**:
- the necessary equipment
- the target (level and age of users)
- the topic, subject of lessonware/courseware
- the kind of software: drill and practice, tutorial, simulation, problem solving, game, tool.
- the monitoring facilities within product.

Other questionnaires address,

- **reasons for buying or using** such a product. The user indicates the motivations for accepting or rejecting the product.

- ways this product will be used in **pedagogical situation**: setting it up within a curriculum, difficulties and how overcome them.

- product **evaluation by pupils**: do they like the product, would they take it at home, etc..

A Japanese researcher has been doing interesting work in evaluating market educational packages, and in comparing criteria on which there are significative differences between products considered as good/excellent and products considered as bad/unacceptable.

A third trend, which has been opened by CONDUIT (An institution based in University of IOWA), takes into account the **specificity of the evaluator**. The evaluator has to indicate to what extent he considers a criteria to be relevant to the evaluation he is conducting.

In France and United Kingdom, such questions have been raised and researchers have attempted to mix all those approaches. Questionnaires allowing evaluation of the evaluators and establishment of a typology of user have been elaborated in order to complete evaluation questionnaires for products. This work seems to have reached **two limits**.

- One limit concerns the time spent in evaluating products. A questionnaire is better but more time consuming to go through and summarise.
- Another limit lies with the lack of culture within this area. Could somebody who has never seen a painting understand the rules and criteria of judgements on painting quality? We have no culture about software style, graphics, relevance and impact. Building evaluation criteria helps to build such a culture, but further effort is needed to understand the semiology of those new technical interfaces and of the virtual worlds they create.

Evaluation is an important issue for a better understanding of the ergonomics of knowledge communication and knowledge acquisition. It should not only relate to new media but to traditional ones. How many textbooks or university reference books would pass a users test? Perhaps few would survive.

Self-assessment

The new technologies are primarily used as formative tools. They fail for the most part to meet the requirements of formative assessment. Assessment which offers learners support, develops their motivation and assists them in developing their studies is still mainly provided through written, or face to face communication with tutors.

3.5.3. Requirements and Options

1. **To assess learning efficiency in the context of new learning environments**, there is a need to develop tools and methodologies for assessment, in different contexts and with different sets of actors. Ease of evaluation is a key issue in order to facilitate the adoption and implementation of learning technologies.

2. **To investigate the user's interest in specific learning materials.** Specific tools and methods are already requested here, but evaluation could be related more closely to the market potential of products.

When testing a new arcade game, ATARI would install it at some remote location, away from competitors' eyes. Most of the evaluation came from counting the number of coins put in the machine at the end of the day. Though not completely satisfactory for education, this kind of "evaluation" is required. Indeed a product may be perfect but used only by a limited number of people in all Europe. It is necessary to know which part of the market it covers.

In a similar way, specific pieces of software should be developed in order to test the use of learning materials.

If coins play an important role in arcade games evaluation, bauds offer the proof for success on a network. Some of the videotex hosts which compete to offer their services to information providers offer functions to measure the quantitative **measure of services' use**. They rarely provide information on consultation features per page or per rubric inside a service. This requires software which is not provided with standard servers, though such functions would be extremely helpful in the improvement of services and to obtain market analysis on information consultation. **Evaluation of users' itineraries** within a courseware, an interactive video or an information service also provide fruitful information to build tutoring, monitoring and help systems.

3.6 DESIGN METHODOLOGIES

3.6.1. Statement of the Issue

One of the critical factors in the success of open and distance learning courses is courseware design. New information technology can ease the uptake of distance and open learning methods in different areas by providing tools for the planning process and for the actual design of course materials.

3.6.2. Description, Status and Trends

The design and development of open and distance learning materials can be described in two steps: the first step concerns the overall planning or design of the course, the second deals more specifically with how you implement the chosen teaching (or instructional) strategy in the design of the course materials.

The overall planning of a course for open and distance education comprises the following tasks:

- determine the needs of the clients or potential learners
- specify learning aims and objectives
- determine an instructional strategy
- select presentation media

The implementation of the teaching strategy (the design) of course materials involve the following tasks:

- prepare the learning materials
- ensure that materials are adequate
- ensure cultural and environmental transferability (interoperability)
- test and finalise the learning materials

The key issue in the design process is the decision on which teaching strategy is going to be used, as the choice of teaching strategy has very strong implications for the actual design of the course material and the media to be used.

The design methodologies must ,therefore, take into account not only the more specific design processes involved in the authoring process, but encompass the whole of the design process.

The Planning Process.

In planning distance and open learning courses one has to take into account the potential students' former knowledge of the subject and their study experience. From there it is possible to specify the learning needs of the target group. In general, the more knowledge you have about the potential target population for a given course, the better chances you have for creating successful courses.

The specification of the learning objectives is an issue for debate amongst distance educators. Börje Holmberg discusses the issue in "Theory and practice of distance education", 1989, and arrives at the conclusion that there is a strong case for defining detailed objectives in distance education as distance learning materials normally are prepared in advance and therefore give little scope for improvisation and changes.

One of the crucial factors in distance education is how to offer to the student possibilities which in a real sense determine the way he or she wants to learn. Several new technologies seem to offer that possibility, eg hypertext-based courses and access to virtual libraries. But research needs to be put into this issue as individualised learning can not be brought about if other than students decide the content of the course. The challenge for distance and open learning planners is to what extent is it possible to provide a wide range of study opportunities, with clearly defined and declared study objectives, and at the same time make possible a completely free choice for students. Further research and field testing is necessary to obtain more knowledge on how to specify learning objectives without damaging the possibilities of individualised learning.

Building on detailed knowledge of the learners for the course and the learning objectives, the next step in the planning process is to take a decision as to which teaching strategy and media shall be used in the course.

In the DELTA PRE-PILOT Final Report, the authors have listed what the determination of a teaching strategy involves:

- analysis of the content in terms of learning domains;
- deciding the instructional methods and media, including appropriate learner activities (such as practical work). These must be appropriate to both the learning domains and the resources available;
- determining the form of assessment (if required) for the purpose of judging whether the intended aims and objectives have been achieved "

The decision on teaching strategies also involves decisions on which learning domains the course should cover. The same Report offers a taxonomy of learning domains developed by Gagne and Briggs as the most appropriate basis for specifying the aims and objectives of a course. Their taxonomy covers five domains: Knowledge, Intellectual Skills, Understanding, Attitudes and Values and Motor skills. According to this taxonomy it is possible to specify teaching strategies for each of the course components.

The decision as to which media are most suited to present the course depends on the choice of teaching strategy and teaching domains. The DELTA PRE-PILOT Final Report operates with the following media/presentation methods for distance and open learning:

- lectures/tutorials
- printed texts
- video, audio broadcasts and recordings
- case studies using multimedia presentations
- practice exercises
- experimental work/simulation
- project work
- group activities
- task training

Each of these media/methods have their specific characteristics related to the learning domains. For example printed text is especially suited for bringing about understanding of abstract processes and theoretical course components while visual media are more suited for demonstration of practical skills and documentation. Computers have a very broad application area in the teaching process. They can be used for retrieval of knowledge (virtual libraries, databases either remote or local), support tools (locally by special packages and remote through access to e-mail systems, conferencing services and assignment services), simulations (remote or local access to simulations programmes), updating of learning material (remote or locally) and as direct teaching media through CBT-programmes.

The media/methods also have strong implications for the different learning strategies the potential learners can adopt for the course. Therefore the decision on media and teaching strategies has to encompass the decision on which learning strategies should be offered to the students. This choice will be based on the knowledge of the different learner models discussed in 3.1.

In general it is agreed that a rich mix of media and methods make the course more accessible to more students. However the choice of media has to take into account which media the target population and producer have access to. That is to say that the planning of the course also has to take account of the resources involved both on the receiving and production side.

The Design Process.

Intensive research has been carried out into the design of and course materials for the traditional media in open and distance learning: printed text, broadcast and recorded radio and television, while the research on design of CBT-materials, interactive video, multimedia courseware is still in its early stages.

The common characteristic of the traditional media is that they offer general presentation of the learning content in a linear structure and that it is costly and difficult to update them. Printed text and recorded radio and video are less rigid than broadcast material. The presentation in printed text and recordings can be made in a more or less personalised manner, eg using questions and an interactive writing style. These media offer to the students furthermore the possibility of numerous repetitions. The broadcast media are much more ephemeral in their presentation. They offer no way of repetition or flexibility in scheduling. The broadcast media normally also have to take into account aspects other than teaching , as they address a broader public than the students of a given course.

What the new media offer is the possibility to present learning content in a much more flexible and personalised way and to structure the content according to the preferred study method. Furthermore the new media offer a possibility to integrate all the traditional media in one multimedia package with easy access to updating learning material. Using workstations with access to CD-ROM and VDI, and remote access to information bases, it is possible to produce fully integrated courses which can be presented in an individualised way, for instance combining text, sound, video, simulation, interaction either locally with the programme or remote to tutors and peer groups.

However more research is required before methodologies for design of course materials which fully exploit the rich learning potential and possibilities offered by the new media can be developed to the same stage of professionalism as the design methodologies for the traditional media.

Planning procedures and design methodologies for the different media exist within each of the major companies or institutions which produce open and distance teaching materials. Research on the methodologies and good practices for providing distance and open learning materials is on an advanced level concerning the use of traditional media. On a European scale however there is no consensus of planning and design methodologies. Portability of teaching materials on a European scale is hampered by the cultural and language challenges as well as the lack of common approaches in design methodologies.

The common trend in research into teaching effectiveness shows that the most important factor for the student's uptake of the learning materials are possibilities offered by the course producers to learn in an individual manner, on the time and space best suited for the individual learner, and in a way which allows the student to chose the relevant parts of the course according to the learning needs and previous knowledge of the subject. The trend on the producer side is moving in the same direction to the provision of more flexible, modular learning materials offering possibilities of targeted and individualised learning using the new media.

The development of high quality open and distance learning materials based on Information Technology is a highly complex process. In most situations it is still considered more an art than a technology. To satisfy the growing need for a more professional and industrialised approach is required. The term courseware engineering has been suggested for this technique. The term reflects the industrialised nature of the courseware production, where units are designed, linked, tested and finally released on the market. It encompasses the whole range of activities which need to be carried out, analysis and specification, design, prototyping, authoring, testing and validation, production and marketing. The technique formalises all the steps in a way which makes possible more industrial and team-oriented approaches to the production of courseware materials. Although attempts have been made to formalise these techniques most of the work has concentrated on development of tools to facilitate the authoring process, whilst tools that support the earlier stages of the design phase are still rudimentary. A consistent theory of courseware design may yet need to be developed.

The challenge in courseware engineering is to develop a theory and the related tools that enable a team to work together in a efficient way, as courseware production is an extremely complicated process involving a wide range of activities and actors. Content experts must organise the material to be presented. Courseware designers have to lay out the instructional strategy to be followed and the details of the learners interaction. Graphic design is needed to create interactive screens. Programmers to program either in a programming language or in a CAL-language. Evaluators need to test the product before releasing to the market. Publishers then take over the product for the final production, and marketing staff introduce the product to the market. As the early phases of the production cycle (planning and design) take up to 50% of the total effort put into the production of courseware, there is an urgent need to ameliorate this highly time and effort consuming stage of the process.

The designer and producer of learning material (courseware) will be able to benefit from the spectrum of computer based aids for software engineering (CASE). It is expected that development tools will also be tailored to the production of instructional material, and will allow complex courseware to be created and maintained economically and with reduced risk. Again, developers and producers can be supported in two ways. Communication networks allow for better cooperation throughout the production cycle, including the analysis of pedagogical requirements and the assessment of a product's pedagogical quality.

Knowledge based techniques will have a particular impact on development: knowledge bases will accumulate experience both in the form of pedagogical design principles and prefabricated courseware modules. Even in the short run, a courseware engineer may draw on software libraries and knowledge bases developed for other purposes than instruction, e.g. for the design of a product or for its maintenance.

Special attention needs to be taken to design of interactive courseware. While much of the conventional CAL materials can be designed following the paradigm:
Input - complex calculation - output - wait for next input.

Interactive courseware requires far more complex construction principles for being able to put the control of the learning process in the hand of the learner. Considering the current state of the art in both instructional technology and software technology (especially IKBS techniques), neither simple nor complex branching structures are sufficient.

Recent and very promising approaches are based on concepts of exploratory training, simulations and hyper-media based training. Both require multimedia integration and are highly interactive. The term 'simulation based training' covers learning situations where microworlds or objects to be learnt about are simulated. Hyper-media based open learning material covers all kind of integrated information sources through which the student can navigate in order to explore huge amounts of information contained in these sources whether they are based on knowledge bases, hypermedia principles, graph-theory or networks. Both simulation and hypermedia based training require integration of several types of open learning techniques. Simulation is not enough, it must be supplemented with other forms of guidance or instruction for the learner. This requires sophisticated systems with student modelling, navigation tools, help facilities etc.. There is still a need for efficient methods and tools.

Quality control is another crucial aspect of the design process. So far little attention has been given to how the quality can be assured during the development process. Several reasons could account for this: The lack of a formalised description of the development process makes it difficult to define clearly which control activities should be performed in respect to which construction activities. There is no consensus on a set of quality criteria, and no clearly defined courseware architecture which breaks the course down in separate functional parts that can be evaluated individually.

A methodology for quality control is needed in order to make it possible at an early stage in the course development process to predict quality problems. Stages in the development process need to be identified at which predictions of the quality of the final product can be made. The relations between these prototypes at these stages and the final product need to be defined. Quality criteria for the different stages in the development and production process need to be defined. Improved quality control during the development process can be achieved by developing training programs for the different actors involved in the development process or by integrating knowledge based quality control tools in the authoring systems.

Summarising with regard to **the design phase**:

- there are few methodologies for designing of courseware

- the tools such as idea processors, hypermedia and course directories are not sufficiently specified for content/topic definition

- the new materials are insufficiently used (except for example image banks, e.g. medicine) because of lack of information, portability, etc.

Design methodologies are not sufficiently specified: no standard training scheme on designing software has been developed as yet; a very limited number of exchanges on educational software mock-ups have been realised; there is hardly any practical guide for designing and developing multimedia learning materials.

Design is frequently supposed to be covered by use of authoring languages. Many of those languages are based on the idea that courseware has to simulate the trainer. Given the state of the art in technology and in authors skills, a lot of boring text-oriented products has been brought about. Conceptors are asked to exploit functionalities of systems in a pedagogical way.

Apart from the authoring languages which mainly aim at auto-training, there are very few tools which help potential authors to develop multimedia learning materials. The existing ones are as difficult to use as the authoring languages. Moreover, design of learning materials is still a bottle-neck. It involves skills which are far more complex that the writing of textbooks.

In any case - autotraining or supportive environment - the transposition of an expertise through those systems require new methods. There is a need for **collaborative working** between domain experts, programmers and pedagogues. There is a need for concern on how students attitudes, nature of knowledge and teaching style may influence methodologies and production. Steps which lead, from an interactive script and scenario, to an individualized multimedia product have to be carefully explored. Most of the successful experiences of collaborative design (e.g. in Denmark, Norway, Sweden and Ontario) are based on new managements of human resources.

There is a need for a common European approach to the design of courseware and a common approach to the media chosen for the presentation of multi-media courses. This aspect has been partly addressed by the DELTA Exploratory Action in the context of the developments of Portable Educational Tool Environment (PETE). Contractors of the exploratory phase have expressed the idea that there could be several Portable Educational Tool Environments, according to the different Learner Models and Learning Styles. Work on standards and interoperability complements this aspect.

Beyond the DELTA exploratory action, overall concern has been expressed on the necessity for an **integrated approach**. It is important to handle together the different aspects of the strategy: infrastructure, production, market, implementation and technology.

European conceptors and producers should be able:

- to improve their analysis of pedagogical strategies,

- to define the specific needs for designing methodologies,

- to define the specific needs for software development systems,

- to have access to decision-making tools.

3.6.3. Requirements and Options

The intention of the DELTA exploratory phase has been to concentrate the R&D resources in the field of authoring systems and tools, and not on the production of courseware and teacher training material as such. However, it requires the creation of the tools which will eventually support training and productivity of authors, and which will support the production process:

1. The research and development aims **to specify common European technical and logistical support** for making the authoring process more professional and to improve:
- courseware quality and relevance to the learning requirements,
- economies of scale in content-definition, courseware-design, implementation and the evaluation processes,
- standard process to facilitate certification of distance learning courses on a European scale.

2. Design: areas in common
Related tasks may focus on the possible common specifications of products within one learning style:
- adventure games environments
- problem solving environments
- action environments
- multimedia terminology basis
- simulations

The user interface and the visual display environment (i. e. windows, colour) may also include common features according to the domain. They may work on common features in domain-related elements: equations, molecules representations, graphical illustration for electronic components.

3. Harmonisation and interoperability of specifications for a multimedia environment should address tools for mixing, windowing, image manipulation and processing, "painting", highlighting, voice-over, sound synthesis, electronic music, additions of harmony and rhythm. It should also address facilities for recording and storing the finished product at high standards of fidelity and definition.

4. Furthermore, attention should be given to **remote access and sharing of resources** by different authors and producers. Way of making the planning and management of the development process more effective and efficient in term of development time and resource usage is also a central issue.

5. Currently, only the final stages of the production cycle of the systematic development of courses is supported by adequate tools. Consequently, course development is labour intensive and requires an unreasonably high level of knowledge and skill on the part of the developer. Tools are needed which improve the reliability and efficiency of development and which incorporate information and intelligence on relevant pedagogical and cognitive principles.

The issues of importance include: development of learning materials, interaction and interactivity and learning and learner models.

6. Integrated learning environments are necessary: their design must be built upon a base of empirical pedagogical principles, and best current knowledge in regard to learning and cognition. The learning environments envisaged must incorporate a diverse range of learning models (e.g. strategies) as well as learner models which allow for the intelligent control of the actual learning process and for sophisticated interaction between learner and system.
In designing a Learning Environment several dimensions have to be considered including content, method of instruction and social context of learning. In regard to content, a powerful Learning Environment should facilitate the acquisition of four kinds of knowledge i.e. domain knowledge, heuristic methods, metacognitive strategies, and learning strategies.

7. The design and construction of any Learning Environment depends on the domain to be studied. For this reason research, development and experimentation in a number of specific domains is needed. The model-based simulation of complex systems is an especially important feature of an advanced environment for exploratory learning: simulation provides the context of practical use for the knowledge and skills being acquired.

8. The design environment must cater for the systematic development of multistrategy, multimedia courses and learning material. Tools and methods must be available for the entire design and development cycle and not only the final stages of so-called 'authoring' and production. There will be a degree of domain specificity in relation to the methods and tools required in the Design Environment. For this reason again, research, development and experimentation in a number of specific domains as well as at a generic level is encouraged. Specific tools for the design and development of simulators are of importance.

9. The competent design of advanced technology-based multi-media learning materials is a necessary precursor to their production, and the design phase includes everything that precedes what is normally called authoring. Design is concerned with determining what functionalities, content and media are required for the materials and must be based on pedagogical principles which are heuristics/rules/guide-lines abstracted from a wide range of learning contexts and environments which have, or may be expected to have, relevance in the determination of instructional strategies for the effective use of advanced technology in learning.

Making explicit the principles and requirements on which the design is based, the various intermediate stages in the design process, and the final output stage of the design process will make that process more transparent and accessible to collaborating authors and designers, and to those who wish to learn from earlier successes and failures. It will facilitate the development of tools to support incremental, collaborative and distributed design with clear revision paths.

4. LEARNING TECHNOLOGY

4.1. PORTABILITY, INTEROPERABILITY AND STANDARDISATION

4.1.1. Statement of the Issue

Standardisation, portability and interoperability is a prerequisite for an effective and economic open learning market. Standardisation should be both technology and market driven and based on existing and emerging standards and conventions.

4.1.2. Description, Status and Trends

In several areas it will be necessary to define standards on top of existing and emerging technology standards and conventions (Eg OSI, X-Windows, UNIX), specific standards and conventions for educational technology. One major problem identified with this, is that standards lag behind proprietary innovations and are often defined with no involvement of end users.

Overall there are virtually no existing standards addressing educational technology and flexible and distance learning as such. There are only a few attempts to come to a standardisation in the area of learning technology. The DELTA Exploratory Phase aims at harmonizing the European internal market for educational technology based on open and distance learning (industry, broadcasters, universities and producers of educational material).

4.1.2.1. Systems Standards

Dedicated Configurations

Only a few examples of configurations developed or harnessed specifically for educational usage exist.

PLATO network, set up by Control Data in the United States, was **one option** aiming to answer part of the local and distance learning requirements. This option failed though more than twelve thousand hours of interactive courseware were available through the network. The human network of teachers-authors which had been set up by Control Data also demonstrated the importance of providing both a service environment for the author and a telecommunication link to the learner.

French DIANE plan was **another option**. It was the most significant attempt yet to build a standard interoperable software environment for authoring. DIANE was a 15 Million FF research project on authoring environments. To make courseware environment-independent, an internal representation mode was developed. It aimed to make courseware, which had been produced through different authoring systems, executable in different hardware and software environments.

A third option relates to building on a common core hardware device. TheMSX; strategy, set up by Japanese consumer electronics manufacturers and by Phillips was targeted at the general public education and entertainment market. I all likelihood, the market and the software products were not mature enough when this initiative was launched. The Acorn/BBC and its follow up, the ARCHIMEDES, have been widely taken-up in the UK, while the PICOLO was specially developed in Denmark for educational purposes. Further examples are the Apple MacIntosh and the NEXT computer. The MacIntosh is considered as a computer appropriate for educational applications. However in Europe it has not become a widely accepted machine (with the exception of Universities), due to the predominance of MS-DOS. The NEXT machine is especially developed for educational applications. This machine was launched in 1989 on to the US market. At this stage, however, it is not clear if the machine will be accepted by the US market, let alone the European market.

Operating Systems(OS)

Overall proprietary systems are applied for flexible and distance learning. Standardisation is based on prevailing operating systems. Three major world standards will be described.

MS-DOS has become a world wide standard for desktop computers confirming the IBM-PC architecture. MS-DOS is basically single user and single task oriented, some applications find the severe limitations on memory size a drawback. Although improvements have been achieved over the years (memory access, multiple windowing, faster processors) the system in not best applicable to complex and multi user oriented educational purposes.

OS/2 is IBM's proprietory successor to MS-DOS and a multi tasking single user system. It attempts to combine applications (communications, database, wordprocessing) with the OS. Up until now OS/2 has not well established in the market and is considerably lacking in applications. Recently however most, if not all, major software houses have begun to support OS/2 and its take up by the market is rapidly increasing.

UNIX is a non machine specific operating system and offers multi user, multi tasking capabilities. For UNIX a very wide range of software is available and it is the principle development environment for OSI software. Its major drawback at the moment is a lack of user interface sophistication. For some workstations like SUN, facilities are incorporated to develop complex and user friendly software (simulations and AI shells to build expert systems), by means of object oriented high level programming tools and high quality graphics. .

The MacIntosh operating system has multiple tasking capabilities and a very sophisticated user interface environment (GUI) embedded in the OS. However due to Apple's marketing strategy the system is completely isolated.

There are currently several means by which machines running different operating systems can communicate. These methods are based on network protocols which are well established or which are going to be well supported by all manufacturers. The communication of information between different operating systems does not therefore present any special problems.

World market penetration and forecast for operating systems

Worldwide Systems by Operating Systems (in thousands of units)

	1983	1985	1987	1989	1991	1993
MS-dos	855.0	3994.7	7368.4	10166.3	10828.8	10162.3
UNIX	45.4	132.1	326.7	780.3	1097.0	1385.4
OS/2	0.0	0.0	128.8	937.5	3993.8	8624.8
PICK	3.3	18.5	30.9	49.8	87.8	130.7
CP/M, MP/M	584.7	919.7	1089.6	951.3	795.9	663.8
OTHERS	90.0	70.6	41.1	13.3	12.4	15.8
PROPRIETARY	8619.5	8180.2	7734.5	8656.0	11133.1	16625.4

Peripherals

A wide range of storage devices with different functionalities are available. Developments are particularly fast in the area of multi media storage and some de facto standards are evolving. However at the moment the potential use of optical storage media for Advanced Learning technology can be restricted to CD-A/CD-ROM and LV-ROM. All the other media are only in the "test and evaluation stage" or are still under development.

Magnetic storage shows a fast increase in capacity, but limitations exist with the storage and retrieval of multi media.

Optical media offer large capacity with improved functionalities for multi media storage. A wide range of optical media is available, while standardisation is becoming world wide.

From the emerging technologies it is possible to envisage 3 categories of multi-media workstations in approximately 5 years time.

i High range multi media workstation. UNIX based and derived from graphic workstations (price approx. 20000 - 30000 ECUS)

ii Mid range multi media station MS DOS/OS 2 or MAC OS based (price approx 10000 - 15000 ECUS).

iii Low range multi media workstations CD RTOS or AMIGA DOS based (price approx 3000 - 5000 ECUS).

4.1.2.2. Storage and Information Representation

In the area of information storage, in terms of data structures, access and query hardly any standards are available except for data interchange and multi media document representation.

Several database methodologies exist (hierarchical, networked, relational), but no standard exists in terms of data-structuring. New developments are directed towards semantic, object oriented and distributed DBMS'. Currently hypermedia based systems draw a lot of attention in the educational field. Two major developments can be identified: Apple MacIntosh based HYPERCARD and MS-dos based GUIDE for hypertext and NOTEBOOKS (IBM), which is more education oriented, but not marketed yet.

In the area of database query some major standards exist, such as SQL. SQL is accepted by ANSI as de facto standard, while ANSI and ISO are developing jointly SQL2 as standard query languages. New developments especially natural language based query, have not been incorporated yet.

The whole *area of database access* is problematic from the point of view of standardisation. Database access is totally non-standard and overall not very user-friendly. For database interfacing several on-line access standards can be identified:

- the recommendation X400, for message handling;
  X400 offers standards for a Message Transfer System (MTS), providing a reliable store-and-forward multipoint data transport capability and a Interpersonal Messaging System (IPMS) as a layer on top of MTS, providing multi media personal communications.

- the recommendation X500, for directories;
  X500 deals with the OSI Directory/500, a distributed database holding information to ease communications. The first version of the standard was ratified in 1988 by CCITT and ISO. The initial applications involve OSI and X400 MHS for user friendly naming and distribution lists. The architecture is based upon a number of Directory Information Bases (DIB) interconnected among themselves, which can be queried using the Directory System Agent (DSA), a set of applicative processes which regulates the access to the DIB.
- standards for the representation of multimedia (text, images and graphics) documents (ODA, SGML)

4.1.2.3. Telecommunications

There are many standard organisations dealing with different aspects of communications. The two most important and influential international bodies are the ISO and the CCITT.

In a transnational European context ALT implementation could be based on distributed computer systems involving several processing sites interconnected by a wide area network. Distributed computers can be categorised as either open or closed. Open systems can communicate with other systems and clearly require adherence to OSI (Open Systems Interconnection) standards. Closed systems, on the other hand, have no need to communicate beyond their boundaries.

OSI
In the late 1970s the ISO (International Standards Organization) formulated an *OSI Reference Model for communication services* to allow an application process in any computer to freely communicate with an application process in any other computer supporting the same standard. This model was termed the ISO reference Model for Open Systems Interconnection (OSI). The complete communication subsystem is broken down into a number of layers each of which performs a well defined function. Each layer describes a part of the communication process. In each layer functions are specified that must be taken care of within the layer, also specified are the interfaces between the layers. These layers are application; presentation; session; transport; network; link and physical.

The OSI model has grown in the long process of international standardization. Standards can be found for every layer and for many applications. The problem is not the proliferation of standards, but the certification of conformance of these standards to the OSI-model. Therefore most European PTTs have set up conformance-testing laboratories to certify software and hardware in this regard.

In conformance testing it became evident that a standard is not sufficient for implementation. So, although enough standards have been formulated, only a few are supported by products from computer industries today. However, the number of these conformance-tested standards is rapidly increasing, bringing closer the possibility of open communication with almost any other system.

4.1.2.4. ISDN

In the field of communications an *ISDN infrastructure* is developing. CCITT standardizes ISDN and therefore uses a model of ISDN. In this model the services are separated from the network. The interaction between services and network are described by user/network access interfaces. The Terminal Equipment support the services. The terminal equipment is the least standardised part of ISDN.

Message handling: message handling services are internationally standardised by the CCITT. Standardisation started in 1981 and in 1988 was improved for operational use. These standards are the so-called X400 series. In a few European countries MHServices according to these X400 standards are in experimental use.

Videotex: internationally, three videotex standards are present. In Europe all countries except France and West-Germany use the Prestel-standard. France has its own standard (ANTIOPE;; Acquisition Numerique et Televisuelle d'Images Organisees et Pages d'Ecriture). West-Germany adheres to the European CEPT standard, a standard for all European PTTs (CEPT stands for Conference Europeenne des Administrations des Postes et des Telecommunications).

Networks: overall the OSI standard applies for network (LAN and WAN). For Packet Switched Networks (PSN) X.25 is an internationally agreed network access protocol that has been defined to interface data terminal equipment to a packet switched network.

4.1.2.5. Man-machine Interaction (MMI)

One might argue that there are as many approaches in user interfacing as there are types of computer. Two approaches are however considered of importance in relation to the educational field. Firstly due to the predominance of 8808/MS-dos type of environments the SAA (Systems Application Architecture) of IBM is setting a de facto standard. SAA comprises a family of user interfaces, seeking to let any terminal handle any SAA application. SAA as such doesn't define a MMI standard and incorporates a wide range up to Graphical User Interfaces. Basically SAA is keyboard oriented. Graphical User Interfaces (GUI) represents the second major approach in MMI. GUIs are based on a windowing system (Eg. X-Windows), an imaging model (Quick Draw [MacIntosh], PM [OS/2]) and a application program interface (API) (Eg. Open Look for SUN workstations).

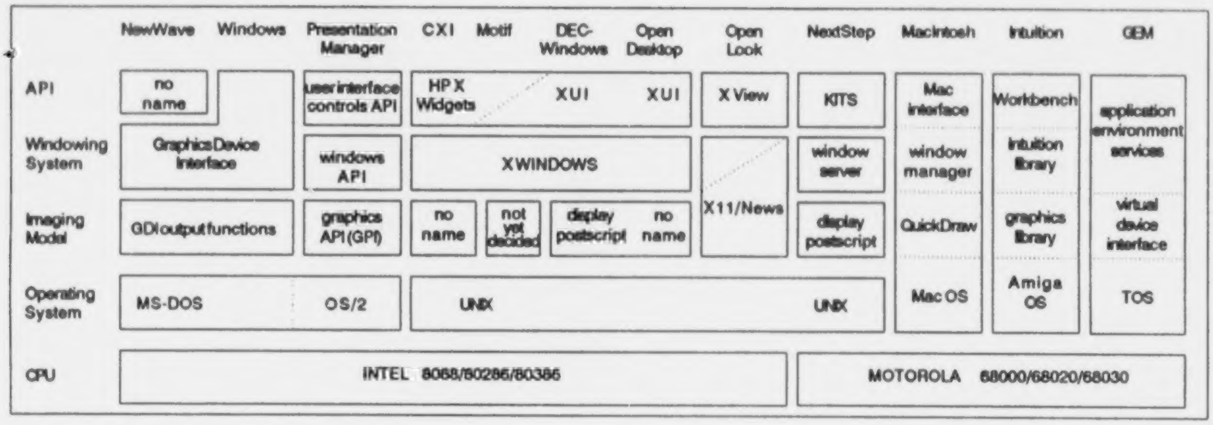
Windowing techniques: The various threads of development in windowing interfacing (also called Graphic User Interface- GUIs) form an extremely complex picture. The subject is relatively new and developmentally still in a state of considerable flux, so it is unclear at the moment what direction will be taken by users. It is also unclear what specific use will be made of windowing techniques by ALT software, and until that is defined, there is little more that can be presented as specific to ALT. It is clear, however, that the trend in computer usage is towards GUIs and away from the traditional command line where the user types a textual command. It must therefore be assumed that new ALT software will take advantage of these developments and use GUI; as the prime means of user interface. Different approaches: Apple Mackintosh GUI; MS-WINDOWS; Systems Application Architecture, Presentation Manager; X-WINDOWS developed at MIT; DECwindows; OSF/MOTIF; UNIX; NeXtStep.

Trends in GUIs are set by NextStep (Next Machine) and NewWave (Hewlett Packard) where they incorporate user facilities and tools that become in fact full size applications.

It is currently impossible reliable to predict what system will emerge as de facto standard, but there seems to be a significant acceptance of portability as a primary goal for windowing interfaces Eg. X-WINDOWS and MOTIF.

ICONS and Graphical symbols are more and more applied for MMI. However there are cultural differences in this area and icons and symbols are not easily transferred from one culture to the other. There is limited standardisation in this area, but not related to the educational field. In some instances standardisation is prevented by commercial policies. Apple are actively prosecuting companies who are developing MacIntosh look alike desktops, which use equal icons and symbols.

Overview of Graphical User Interfaces


NewWave
Windows
Presentation Manager
CXI
Motif
DEC-Windows
Open Desktop
Open Look
NextStep
Macintosh
Intuition
GEM
API
Windowing System
Imaging Model
Operating System
CPU
no name
Graphics Device Interface
GDI output functions
user interface controls API
windows API
graphics API (GPI)
HP X Widgets
XUI
XUI
XWINDOWS
no name
not yet decided
display postscript
no name
X View
X11/News
KITS
window server
display postscript
Mac interface
window manager
QuickDraw
Mac OS
Workbench
Intuition library
graphics library
Amiga OS
application environment services
virtual device interface
TOS
MS-DOS
OS/2
UNIX
UNIX
INTEL 8088/80286/80386
MOTOROLA 68000/68020/68030

4.1.2.6. Application Standards

Layer 7 of the OSI standards is under development, but there is at this stage limited standardisation on the application level. Standardisation is being established through the ODA/ODIF standard for text presentation and text exchange only.

Document transfer protocols: The main document protocols are Standard Generalized Markup Language (SGML), used mainly by publishers and Office Documentation Standard (ODA), a more generally applicable protocol, which is promoted by the CEC. For both there exist products implementing these protocols.

ODA (Office Documentation Architecture) conforms with OSI layer 7 (ISO 8613 and CCITT T.410) and provides for a standardised information structure for representation of documents. Documents produced according to this standard can easily be interchanged among different environments and document processing systems. Multi media elements are brought into this standard by the T.416, T.417 and T.148 recommendations defining the content architectures. These architectures are based on:
- character coding of the CCITT recommendation T.61;
- interval coding technique used in Facsimile (T.6);
- CGM (Computer Graphic Metafile) derived from GKS.

SGML (Standard Generalized Markup language) is a standard more widely used in the USA.

The transfer part of ODA is described in the DTAM (Document Transfer Access and Manipulation) protocol (T.431, T.432 and T.433). Document, communication and terminal characteristics are specified in T.500, T.520 and T.560, and are applied in Eg. Teletex, Facsimile, Videotex.

Teleloading Services: Two approaches are available, telesoftware protocols allowing software transfer from a server to a videotex terminal, and application structure teleloading protocols, defining applications as standardised data structures downloaded as a whole to any terminal.

Teleconsultation applications protocols: Two issues are currently under consideration:
- X.29 in line with current Videotex;
- ODA/DTAM set within OSI (including already a multi media component, but lacking an interactive component);

Interactive Media Representation: The Representation of Audio Visual Interactive Applications (RAVI) is an up and coming standard. RAVI aims to represent applications in a structured virtual manner as in the ISO and CCITT standards for document structure and virtual terminals.

The RAVI specifications are based on the EPTC-ECMA videotex coding standard known as TCD 06-01, which in itself is again based on the OSI graphic standard GKS. Furthermore for syntactical description the ANSI ISO 8824 or X409 (CCITT) has been selected, as well as the ISO 8825 or X409 (CCITT) coding method for the syntax.

Learning Material Development: Software development methodologies exist in large varieties, whereby most software houses have developed their own standards and protocols. In knowledge engineering hardly any methodology exist, with the exception of the KADS-methodology developed in the ESPRIT project P1098. In the area of learning development the DELTA project SAFE (D1014) aims to specify an Open System for Instructional Design (OS-ID). OS-ID is intended to provide an open workbench capturing a wide variety of design, authoring and production tools.

4.1.3. Requirements and Options

4.1.3.1. Systems Standards

There is no indication that industry will provide a market for dedicated learning workstations. It is more likely that available and well known technology will be harnessed to learning requirements, especially with regards to peripherals and services. Standardisation is therefore more likely to be realised in terms of OS and peripherals.

A possible exception could be CD-I, because this system provides good functionalities for education and is aimed at a (more generic) mass market, bearing in mind the low cost and the full compatibility with CD-A.

The portability of software (ease of conversion between operating systems) is of prime significance in a multi-OS marketplace.

1. Language: the language of choice for portability is classically C, but in a numerically-intensive environment (Eg the teaching of mathematics, physics, statistics, engineering, etc) there is some support for showing consideration to FORTRAN-77 which is very nearly as portable.

2. Host Operating System: UNIX (or UNIX compatibles such as CHORUS) is the development system of choice, usually on account of its unique position of being available for almost any machine and because of its close association with the development of OSI software. Strong cases can be made, however, for using both PICK and VMS (DEC) as a part of the development and delivery environment.

3. Networking: There is a presupposition that the development networking environment for ALT software would be compliant with the OSI Reference Model.

It is very clear that significant effort will be needed to develop ALT software and to exploit its usage in an environment of multiple operating systems. The DELTA programme is well-placed to take advantage of this requirement but considerable further work is required.

In particular, the development of learning materials hardware configurations and tools should be more flexible with the aim of giving better facilities for the development of portable learning materials.

Multiple tasking, multiple actor and distributed OS, advanced storage methodologies (CD-I, CD-ROM/XA, WORM) and dedicated engineering environments (as addressed by the ESPRIT project ATMOSPHERE) should be taken in account.

4.1.3.2. Storage and Information Representation

There is a strong need for standardisation in this area of interfacing data bases. Standards are required both for devices, communication protocols, information representation and user interfacing. The DELTA project LEAST (D1001) aims to specify standards and protocols for information (courseware, hypermedia and knowledge base) representation and interchange formats.

4.1.3.3. Telecommunications

ISDN will provide integrated services data and voice transmission, electronic mail, videotex or image transmission. As such the technologies offers excellent opportunities for flexible and distance learning.

For learning technology standardisation should be in accordance with developing standards in the telecommunications field as defined by organisations such as ISO, CEN/CENELEC, ETSI, CCITT and CEPT. However for educational purposes in several areas further standardisation of telecommunications services is required:
- standardised multi language user interfaces and standard protocols, facilitating usage by non-specialists;
- multi media data exchange;
- image handling;
- tele-accounting.

An intercept strategy is needed to take full advantage of the future capabilities of IBC, in order to develop, by means of advanced communication experiments, a set of standard procedures to handle interactively images at distance for educational purposes.

4.1.3.4. Man-machine Interaction(MMI)

As far as MMI is concerned a wide range of proprietary systems are available (Mackintosh GUI; MS-WINDOWS; Systems Application Architecture, Presentation Manager; X-WINDOWS; DECwindows; OSF/MOTIF; UNIX; NeXtStep). There is a clear trend towards WIMP (windows, icons, mice, pointers). MMI for educational purposes should incrementally be based on generic approaches. There is however a need for dedicated developments.

For networking, available interfaces are very limited. Increased functionality and quality, but above all improved standardisation is required.

Within flexible and distance learning several actors, such as learner, tutor and author, can interact and operate on the same material. Currently there is a discussion whether there is reason for defining a standardised user interface kernel for all actors. DELTA Project ASAP (D1003) is currently aiming at the specification of such a kernel.

MMI is more and more symbolic and based on WIMP. In order to facilitate transnational application of learning material there is a need for the identification and definition of multi cultural and standardised icons and graphical symbols.

4.1.3.5. Application Standards

Document representation: The demands of interoperability mean that any document presentation system which is tied to a particular type or level of hardware is unlikely to prove suitable for ALT usage, where portability and international acceptance are important. For this reason, it is felt that purely visual systems will not be sufficient to handle ALT documentation if a single mechanism for all documentation is required.

There should be three levels of document representation:
1. typescript.
2. screen view. With a bitmapped graphics screen, a typographic view of ALT documents should be available. If possible, this should be the default view of a document.

3. Typographic Print: For ALT printed documentation particularly that aimed at circulation or mass usage (Eg manuals, course notes) a high standard of legibility and design should be insisted on. If documentation can be circulated to students or groups electronically and only printed off locally, some form of agreed standard will be required.

It is felt that a structured and acceptable system such as SGML or ODA would serve the ALT community best, but some substantial software development is required to provide reliable programs to interpret such documents at a local (workstation) level for all combinations of hardware and systems software in use. Such systems certainly exist for TEX, but the lack of an agreed comprehensive graphics facility is a major hindrance. It is judged that widespread availability of ODA/ODIF software is unlikely in the next 2-3 years, but perhaps within 5 years.

RAVI as an evolving standard needs further evolution in several aspects:
- data in documents
- interfacing with other applications
- colour
- annotations in documents
- expanded layout
- security aspects

For learning material development no generally accepted standards exist, even though they would facilitate the creation of a European market. The SAFE project aims to define an Open Structure for Instructional Design based possible standards, methodologies and protocols in this area. At this stage however it is difficult to assess whether this will lead to a more widely accepted approach. The French project DIANE attempted to build a standard interoperable software environment for authoring, but this project was not fully successful.

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4.2. LEARNING CONFIGURATIONS

4.2.1. Statement of the Issue

Flexible and distance learning can take place in widely varying settings. Roughly a distinction can be made between:
- home;
- company;
- institutional.

Each setting allows for specific technological options and sets specific requirements in terms of cost, equipment, support, etc.

Advances in learning technology and price developments for IT&T in general allow for an increase of learning opportunities in each setting.

4.2.2. Description, Status and Trends

4.2.2.1. Home Learning

The majority of home learning is based on correspondence courses; and TV courses. In most instances home learning takes place in a very isolated situation, with limited feedback and support mechanisms.

Although the average household increasingly gets hold over a range of media (TV, video, radio, computer, CD) and communication facilities (telephone, sometimes even minitel;/videotex), these facilities are not extensively used for education and training purposes.

A limited number, but a wide range of different computers are available in the home environment, ranges from low level home computers (C-64, MSX, BBC) to PCs. For these configurations however only limited material for home learning is available.

Video is widely available but again hardly used for educational purposes. A mixture of high costs and lack of flexibility of a video tape might account for this situation.

In several member states of the EC the broadcasting of courses is widely applied for home learning. Cable networks for television are increasingly available, but these networks have limited possibilities for educational usage (information can be distributed through eg. teletex). Two-way cable systems are at an experimental level and are not expected to penetrate the home environment in the near future.

More relevant are developments such as videotex (Minitel). These systems are slowly penetrating the home environment and could serve as interactive communications facility.

For most Open Universities the situation is however different. As far as learning takes place at home it is again mainly paper based. Some initial experiments are conducted making use of videotex and computer conferencing. Furthermore in many cases students can make use of study centres where they can make use of a wide range of media and learning facilities. Some Open Universities (UK, NL) combine paper based courses with the broadcasting of programmes.

4.2.2.2. In-company Training

Flexible and distance learning in industry takes place under completely different circumstances compared to the home environment. Major industries set up their own computer based training departments and are able to invest in advanced learning technologies and pilot test adequate applications. Many examples in Europe exist and major companies are already quite well equipped and have their own networks and support infrastructures, which can be applied to training purposes.

Direct broadcasting by satellite (DBS) is also under active development, e.g. the NTU in the US and EuroPace in Europe. Satellite receivers are still too expensive for the home and educational user, though this is changing quickly (e.g. new AMSTRAD) and there is a proliferation of different standards for receiver equipment.

SMEs however are in a less positive position as they are often not able to invest in learning technology and learning applications. Several barriers can be identified:
- lack of dedicated configurations for education and training;
- lack of learning materials - production is to costly for SMEs;
- lack of know-how and experience concerning the application and maintenance of learning technology.

Overall the technology applied to in-company training; is based on proprietary office systems. Although these configurations are not dedicated to education and training, advances in technology and costs make it possible to harness the technology better to learning requirements:
- increase of processing power (32/64 bits);
- improved input/output devices;
- increase of user friendly OS and interfaces;
- advances in data storage in terms of capacity and media types;
- networking and telecommunications facilities (improved transmission speed and bandwidth)

4.2.2.3. Institutional Learning

Institutional learning is defined by those settings where students come to a professional training institution. This can vary from regular education to training institutes. There is an overlap with home learning whereas several educational institutions (such as Open Universities) make use of distance teaching methods.

In the institutional learning setting examples of highly sophisticated training environments can be identified, such as full size flight simulators (occasionally) or embedded training systems (Eg. linking computer based instruction with robots and flexible automatisation configurations).

Overall even in the professional education and training world the use of learning technology is very restricted. Few examples are available of fully equipped .training centres with all the facilities for flexible and distributed learning.

Use of teleconferencing is under active development, mainly for use within large organisations with several locations. In dedicated public training centres, it falls under the same economic difficulties as "prohibitive charges" as there is no concept of the public teleconference, with individual contribution to fees.

In the last decade, the development of microcomputers has created a move toward the use of computers in schools, given significant sales of microcomputers to schools notably from 1980 (BBC micro operation in UK) to 1985 (Operation "Informatique pour Tous" in France).

Since then, reductions in public funding seem to have reduced or stopped the public effort in that domain. Lack of relevant teacher training and quality learning material also discouraged teachers to use available machines and created a wave of scepticism about the use of computers which has not been overcome yet.

4.2.3. Requirements and Options

4.2.3.1. Home Learning

It is at the moment impossible to assess whether in the (near) future hardware configuration dedicated to education (such as the NEXT machine) will become available at the home market. However there is a tendency whereby PC-technology is progressively becoming better suited to educational purposes. Future PCs need to exhibit, at an acceptable price level, colour display, high quality graphic capabilities, extensive storage capacities, user friendly MMI and system software.

It is not likely that in the near future substantial changes in the home environment will occur. The average citizen will hardly purchase expensive equipment dedicated to learning alone. Therefore developments should take into account the more general technology available. Three possible scenarios can be identified:

- the existing scenario for home learning (correspondence and broadcasting) will be developed further, while more emphasis is expected on improved feedback and communications facilities. Through e.g. videotex or computer conferencing the home learning can more easily get access to information, learning material, human support and peer group learners.
- facilities and equipment for flexible and distance learning can be made available on a local level. Following the approach of Open Universities, study centres and leased configurations can provide mechanisms to enable home based learning. Regional and local centres can provide a human and technical environment which can complete the facilities provided at home. For example, multimedia configurations can there be accessed at shared costs. Dedicated peripherals, such as printers, scanners, plotters, graphical keyboard may also be more available and accessible.
- it is expected that in the near future (5 to 10 years) interactive multi media technology will penetrate the home market on a large scale. CD-I, DVI or next generation optical media will provide a highly standardised environment very well suited for learning applications.

Although suitable configurations will more and more become available in the home environments there is overall concern about the quality and availability of learning materials. Home learning essentially takes place in isolation and with limited support. Therefore it is considered essential that configurations and materials are very user-friendly and offer a wide range of support mechanisms, either through (intelligent) help systems or by on line support. Videotex and teletex might provide facilities to support home learners in the near future.

4.2.3.2. In-company Training

Major industries have the capabilities to invest in technology based training centres.

However in general applications are mostly limited in their scope;
- hardware configurations are often based on proprietary business type computers and lack colour, graphics capabilities and dedicated peripherals;
- software and learning material is in many instances inflexible and not well adapted to learning requirements;
- the development of new learning material is often slow and needs improved efficiency;
- implementation is often stand-alone and lack facilities for communication, support, management and maintenance.

In several instances major industries have developed their own IT&T based training centres. For many industries the development of such centres from scratch is a major threshold. There is a need for ready made networked training configurations, incorporating a minimum of services dedicated to in-company training, such as:
- central multi media storage facilities;
- networking and communications facilities (overall networking is applied in a "trivial" way (Eg. using network file systems);
- facilities for evaluation and assessment;
- tutoring facilities;
- facilities for monitoring and resource management.

There is no indication that industry will provide a market for dedicated learning workstations. It is more likely that available and acquainted technology will be harnessed to learning requirements, especially with regards to peripherals and services, such as:
- **storage devices**
  CD-ROM is penetrating the industrial market, but provides limited functionalities for learning (especially audio and video). More relevant are the CD-ROM/XA, CD-I and DVI.
- **man machine interaction (MMI)**
  In the office environment important improvements have been achieved in MMI. Learning however in many cases requires more dedicated interfacing in terms of input/output devices (high resolution screens, graphical tablets, pointing devices, speech recognition, image scanning) and user interfacing;
- **peripheral integration**
  In industry the linkage of training programmes with specific devices such as Robots, CNC equipment, process facilities is highly relevant. Interfacing computer hardware with this equipment requires special developments;
- **information processing**
  Dedicated operating systems (especially suited for parallel processing and distributed working), desktops with learning tools and software facilities should complement the general purpose systems available.

Another option for in-company training is mainly based on distance teaching. Initiatives such as EuroPace and Saturn, but also national broadcasting show the relevance of DBS. Within this option the major advances required are:

- improvement of feedback and interaction mechanisms;
- facilities for multiple language transmission.

A third intermediate option is highly relevant for SMEs and less advanced regions. Technology based learning can improve substantially traditional, ie class room based, approaches to learning. Multi media databases can for instance be applied to group presentation systems. DTP technology can improve the quality and cost effectiveness of printed material such as manuals and course materials.

4.2.3.3. Institutional Learning

Future requirements for institutional based learning (Eg. Universities and training companies) match in many ways the requirements for in-company training. Additional requirements are:

- dedicated input/output devices for Eg. handicapped people;
- training servers enabling communication and access between wide groups of actors and local, central and remote information and learning material resources;
- on-line multi media storage facilities and servers.

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4.3 LEARNING FACILITIES

4.3.1. Statement of the Issue

The quality of flexible and distance learning not only depends on functionalities of applied systems configurations and the availability of portable and quality learning material, but also on the availability of a software environment that enables or facilitates learning. Such an environment should provide facilities for support, communications and dedicated learning tools.

4.3.2. Description, Status and Trends

Most technology based learning applications are based on separate and mainly incidental packages. In this situation the learner only interacts with individual learning packages which contain (or more often not) all required facilities.

Traditional Computer Assisted Instruction has in general very limited facilities supporting users. Except for direct feedback on performed tasks and on-line reference guides the user has no support. Developments in Intelligent Tutoring Systems (ITS) show however that extensive user and learner support increases learning performance substantially. These systems (SOPHIE, GUIDON, LISP TUTOR) provide guidance based on models of the learner.

As soon as technology based learning is applied in a systematic and structured way, a wide range of facilities are required and not necessarily limited to individual learning packages.

It is acknowledged that substantial and systematic flexible- and distance learning can only be effective if the learner has access to:

- support mechanisms in order to operate the available systems;
- help and guidance in order to optimise the learning process;
- facilities for learning, such as note pads, individualised lexicons, knowledge modelling facilities and individual storage;
- facilities in order to communicate with human tutors or peer group learners and to access on-line information and courseware bases.

Only a few examples of full size learning environments providing one or more of the facilities described above are established.

For example the Open University UK has developed a extensive front-end to their network facilities. Based on an easy to use communications desktop students and tutors can communicate, access information bases and store locally relevant information.

An other example of a state-of-the-art ITS is the support system for UNIX developed in the ESPRIT Project EUROHELP.

Some more elaborated examples have been developed within the MacIntosh environment. These systems are based on the inherent functionalities of the desktop, offering the student facilities for local storage and processing of information, dictionaries and reference guides.

In general however these elaborated support environments are restricted and not widely applied in the market.

4.3.3. Requirements and Options

Learning facilities should allow for effective and independent use of learning environments through intelligent help and tuition systems coupled to intelligent dialogue managers.

Several advances in IT&T are specially relevant with regards to the developments in flexible and distance learning.

Man machine interaction
Major progress has been achieved in the area of man machine interaction. Although for example MS-dos still provides a purely command driven environment, a range of more advanced desktops and help facilities has been developed. It is especially for non-expert users and complex tasks that transparent, flexible and adaptive interfaces are critical. The quality of interaction and dialogue with the system has a major impact on learning performance. Techniques like WYSIWYG, object oriented approaches, mixed command-menu driven dialogue systems, direct manipulation and adaptive user interfaces are especially relevant, but need harnessing to the specific requirements of learning.

Integrated help and support systems
Within office systems environments advances have been achieved at the level of user facilities and support systems. Facilities such as file managers, retrieval/query systems, on-line dictionaries, electronic note books, and also dedicated help facilities on systems usage are more widely applied. These techniques are equally relevant for learning oriented environments in providing facilities that can enhance systems usage by learners and providing tools that indirectly can support the learning process.

Basically two orientations for future developments can be distinguished: application and system.

Application oriented support facilities are bound to specific learning applications. This orientation gives the opportunity to give more in depth and subject related support. Advances have been achieved especially in the area of ITS. Developments are oriented towards:

- student, domain and interaction modelling;
- dialogue or interaction management systems;
- learner expert systems.

The systems orientation concentrates on more generic support facilities. These facilities are not restricted to learners, but offer support for all types of users involved.

Three types of facilities are considered relevant:

- communications
  Communication facilities (by satellite and/or terrestrial) allowing on-line and off-line multiple media (broad band) student-student, student-tutor and other actor communications, facilitating electronic networking and remote access to distributed, multi media data, information and knowledge bases. Special facilities for example translation support, on-line query and retrieval, data and media transfer and tele-accounting are envisaged.

- systems usage
  Examples such as the MacIntosh desktop, GEM, and X-windows demonstrate that standardised, consistent and flexible user interfaces have a strategic impact on the ease of use and quality of usage of IT&T systems. Embedded in these operating environment Facilities dedicated to learning should be incorporated by embedding in the operating environment.

- learning tools
  In a traditional learning situation a learner has a range of facilities available in order to support learning. Information technology as such provides excellent functionalities to incorporate these type of facilities, such as dictionaries, encyclopedia, personal electronic note books and databases etc., in learning systems and make them available to learners.

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4.4 DESIGN AND PRODUCTION ENVIRONMENTS

4.4.1. Statement of the Issue

The establishment of a European market for flexible and distance learning depends strongly on the quality and quantity of available learning materials. Regarding the costs and complexity of learning material development professional and flexible (in terms of learning approaches, media, portability and transferability) development systems are required.

4.4.2. Description, Status and Trends

The first author language TIP was developed around 1960. CATO for the PLATO system was developed in the same period. At the end of the sixties the first authoring systems (Eg. VAULT and TICCIT) began to appear. Since then a wide range of authoring languages and authoring systems have been developed. At the moment, in Europe alone, over 400 different systems are available, while over 20 are used in more than one member state of the EC. Compared with software engineering methodologies and systems which are actually applied, learning material development environments are very primitive, inflexible and not cost effective.

Multimedia interactive learning materials using advanced technology delivery systems are complex combinations of computer software, and other audio visual materials. Present methodologies for design, authoring, and production are labour intensive and result in sector specific, culture specific, and hardware specific materials, which slow down European Market integration.

Overall currently applied systems (with only a few partial exceptions) have a series of major limitations.

4.4.2.1. Implementation Orientation

In general, the life cycle of learning material production can be split into three basic phases:
- analysis;
- design;
- implementation and distribution.

Existing authoring systems and languages are mainly limited to facilities and tools for implementing specifications (screen and interaction design). Several problems with learning material development are related to this. Analysis of the learning domain and setting, course design, functional and technical specifications are essential and complex aspects of the development process. Only a few tools for these activities are available (most design tools are still in a prototyping stage, eg. COCOS, SCALD, FL-IDE, CASDAT) and overall they lack integration with implementation tools. This results either in very labour intensive transformations of designs in computer code or an influence over the quality of the actual design and learning material.

4.4.2.2. Single Media Orientation

Although multimedia applications are not widely available, it is recognized that complex graphics, animations and audio visual media will increasingly be integrated. At this moment however authoring systems only indirectly address multimedia design (Eg. TenCore, MENTOR II, MicroPLATO). In particular facilities and support for audio visual media production and integration are not available, eg. specifications for video production, such as scenarios, shooting lists, editing manuals, are not generated by existing authoring systems.

4.4.2.3. Limited Educational Strategies

In general authoring systems support a limited set of learning strategies (mostly drill & practice and conventional tutoring). Only recently have systems become available supporting alternative strategies such as simulations, ITS and exploratory learning. Only a few systems are available supporting effectively a wide range of learning strategies (PLATO supports a range of strategies and for example DOMINIE produces domain independent courseware and support 8 different tutoring strategies).

4.4.2.4. Lack of Formalised Methodologies

Present software engineering relies strongly on very elaborated formalised methodologies and resulting facilities. For the development of learning materials, de facto a highly specialised and complex software engineering activity, no publicly available formalised methodologies have been developed. Within the DELTA Exploratory several projects (CAMCE D1015; SAFE D1014) are trying to define a formalised methodology and to specify suitable tools and facilities.

4.4.2.5. Single User Orientation

Although the development of learning materials is a complex process requiring a range of expertise, authoring systems are oriented at one single user executing all tasks. Although several systems exist (mainly applied in the US) as a networked application (MicroPLATO, Micro TICCIT, REGENCY, WISE) overall facilities for collaborative and distributed working are lacking.

4.4.2.6. Lack of Formative Evaluation Facilities

Developing learning material should be an iterative process of concept and implementation. Facilities for rapid prototyping and user simulation are critical especially for more advanced types of learning material. Only a limited range of authoring systems (Eg. BOOK 1, REGENCY) provide facilities for this.

4.4.2.7. Lack of Portability and Transferability

Portability as such is a problem area which is not limited to educational technology. In general software development is hindered by the problems related with portability. Standardisation efforts and the development of software layers supporting portability across operating environments (ESPRIT - PCTE, DELTA PETE), cross compilers and multiple code generators (Eg. VAULT offers facilities to generate different codes for different configurations) still did not solve the issue of portability.

Transferability to different languages or cultures is not as such addressed by authoring environments. Recent developments, such as separating content and interaction (knowledge based, object oriented and DBMS - approaches), offer opportunities for transfer and/or translation.

With respect to authoring environments several trends can be identified:

- life cycle approach;
  Formalisation has become an issue for authoring systems. It is acknowledged that professional learning material development is a multi disciplinary activity requiring standardised methodologies and addressing all phases of the development life cycle. Tools for analysis and design are being developed and incorporated. Techniques developed in the software engineering and AI (especially knowledge representation and modelling techniques) are incorporated in recent environments (newest version of PLATO, DOMINIE, VAULT).

- intelligent authoring environment;
  Advances in instructional science and AI allow progressively for the development of facilities supporting the development of learning material. However several major problems, such as domain independence, knowledge elicitation and suitable modelling techniques, still exist.

- advanced editing facilities.
  Either by improving the performance of integrated editors (content, course structure, screen, dialogue) or by interfacing to general purpose editing tools, authoring environments allow for a more advanced and effective design. In the area of knowledge representation especially , tools like ORGUE (flowchart oriented representation) and SNAKE (network formalism) are state-of-the-art developments.

4.4.3. Requirements and Options

In general a wide range of requirements for design and production environments can be identified:

Formalised and professional methodologies covering the full life cycle of learning material development.

The development of formalised methodologies for the incremental, collaborative and distributed design and production of multi media interactive learning materials. Such a methodology should support the whole development life cycle.

Based on such a methodology an integrated set of facilities and tools is required. At this stage a major deficit with existing tools is the lack of integration and/or interoperability.

Basically two options are available. The first option would build on existing authoring systems and aim to develop them further in terms of life cycle coverage, multiple strategies and media, support facilities, etc. This approach would aim at an environment that doesn't require extensive technical knowledge. Such a system could be very cost effective. One drawback however is an anticipated lack of flexibility.

The second option corresponds more with the latest developments and aims at the development of a wide range of dedicated tools that are interoperable. This would result in flexible workbenches capturing dedicated tools and general purpose applications. Object oriented environments are of special relevance to this approach. Within the DELTA Exploratory Phase special emphasis is put on tool sets and workbenches based on a standardised multi media databases capturing all information during the life cycle of learning material development (SAFE D1014; CAMCE D1015; ESM-BASE D1012). Traditional DBMS are not sufficient for handling large, complex and multi media data structures. Promising developments however are object oriented databases. Some relevant research prototypes are INTERMEDIA (Browne University) and ODE(Object Oriented Environment, AT&T Labs).

4.4.3.1. Portability,Interoperability and Standardisation

This area is one of the major thresholds in the establishment of a European market for flexible and distance learning. Several possible options can be identified.

- dedicated target configurations
  The BBC, MSX, MacIntosh and Next machines represent attempts to create dedicated configurations for learning. However not one of them up to now has established itself as a standard. Market forces (learning as such is still a very small market) and rapid changes in technology prohibit the arrival of a hardware standard. Probably CD-I is the most promising configuration that sets a standard suitable for learning in the market. A more promising approach might offer a basic general purpose PC with standardised set of peripherals (CD-I), interfaces (POSTSCRIPT, X-windows) and operating environment (MS-dos [for the time being], OS/2, CHORUS, UNIX).

- virtual representation
  ThePCTE and PETEprojects, and also standards like OSI are solutions that strive to overcome differences between a range of vendor equipment.

- highly sophisticated production environments
  A third option would be the development of highly sophisticated production configurations that could serve a wide range of target machines. Several systems (SUN, MicroVax) and especially integrated multi media workstations (Sony View System, InfoWindow) could serve as a basis for further development. Several manufactures have announced multi media workstations for the early 90s (BULL, OLIVETTI, NCR, IBM, ESD, SONY).

4.4.3.2. Re-use of Material and Information

For printed material there is extensive experience in the transfer from one language/culture to the other. For computer based learning hardly any experience is gained. Nevertheless translation and transfer is a highly relevant issue. Several requirements for the transfer of learning material are identified:

- content and interaction/control flow have to be separated in the actual software implementation (DBMS and object oriented approaches) in order to effectively translate texts, pictures etc.;
- special edit facilities are required in order to adapt different language versions to standard screen layout formats;
- libraries with culture dependent symbols and icons;
- translation tools;
- adequate technical documentation accompanying learning material.

Re-use of existing material or producing generic materials that can be adapted or integrated in dedicated learning applications can be very effective approaches in order to improve cost effectiveness and transfer to different languages and cultures. Production environments should incorporate facilities enhancing the re-use of materials or use generic materials (Eg. picture or multi media databases). Facilities envisaged are:
- multi media indexing techniques, especially for picture, audio and video indexing;
- media and data transfer facilities;
- facilities for remote access and sharing of resources.

4.4.3.3. Distributed and Collaborative Working

Development of learning material is considered to be a multi disciplinary activity. Different people have to work together, although not necessarily at the same location. Collaborative and distributed working is a requirement for future learning material development. However there is almost no experience in this field. Requirements can be derived from software engineering experiences, such as:
- multiple user, multiple tasks and distributed operating environment (Eg. CHORUS);
- central multi media storage facilities and resource servers;
- high speed, broadband communications (IBC) services;
- access control, security of data and charging;
- ASCII and non-ASCII file transfer facilities.

4.4.3.4. Quality Control and Management

In general the importance of quality control (formative evaluation in instructional design) is acknowledged in software engineering. Nevertheless no examples of quality control methodologies and facilities are available in the area of learning material development. Research concentrates on quality checklists of final applications and not on methods and facilities for quality control during the development life cycle. Three basic requirements identified are:
- facilities for automated quality control;
- facilities for rapid prototyping and modelling;
- development of quality engineering process models.

Directly related to quality control are overall management requirements for complex development processes. State-of-the-art is limited to general purpose applications (project planning, spreadsheets, etc.). There is however a need to better integrate management control facilities in future learning material development environments.

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4.5. DEDICATED DEVELOPMENT FACILITIES AND TOOLS

4.5.1. Statement of the Issue

The development of learning material for flexible and distance learning is a highly complex process, requiring a wide range of dedicated tools covering the range of activities.

4.5.2. Description, Status and Trends

Production of learning materials is highly complex activity, which requires a wide range of expertise. In general the life cycle of learning material production can be devised in three phases:
- analysis;
- design;
- implementation and distribution.

4.5.2.1. Analysis

In learning theories many methodologies and taxonomies have been described for requirements analysis and domain modelling. A thorough analysis is acknowledged to form a critical factor in successful learning material development processes. Nevertheless in general author environments provide few facilities to support the analysis processes. General purpose applications (idea processors, text processors, spreadsheets) are occasionally used, but lack specific functionalities for the domain and are not integrated with available systems for learning material development.

In the area of domain modelling several advances have been achieved (Eg. ESPRIT project KADS), specifically in the area of ITS. A range of programmes (Eg. SCHOLAR, GUIDON, MENTOR II, LISP TUTOR) are based on domain modelling techniques. Specific tools for domain modelling are developed within Eg. DOMINIE (flowcharting) and SNAKE (networking), LDS (dedicated editors for content taxonomy, procedures and /prerequisite content) and IDE (hypermedia based domain structuring). In general however experience shows it to be extremely difficult to create domain independent programmes and facilities. In general practice few tools and facilities for analysis and domain modelling are available and actually applied.

4.5.2.2. Design

Three areas of design are distinguished in the life cycle of learning material development.

.i.Instructional Design;

Although a range of theories and methodologies exist, in general instructional design is not yet specified and formalised in sufficient detail. Methodologies are frame oriented and not suitable for a range of instructional strategies. Existing state-of-the-art systems are Eg. COCOS, SCALD, ID-EXPERT, IDE, MOSAIKK. They address many aspects of instructional design. However these systems are not widely applied.

.i.Functional Design;

No formalised functional design method in courseware engineering has evolved. Existing functional design methodologies and facilities have been developed for software engineering, especially administrative applications. However these methodologies show critical deficits, such as lack of facilities for iterative design, user interface design, conceptual data modelling and multi media specification, in relation to courseware engineering.

Available authoring systems in general implement automatically instructional designs. Available tools concentrate on course structuring, dialogue modelling and screen layout. There is often lack of facilities for prototyping and multi media definition.

For multi media design it is mainly databases such as FREEBASE, WORDSHEET, OMNIS5, HYPERCARD, NOTECARD, GUIDE, INTERMEDIA that are available. However these systems provide in some cases direct implementation and don't provide specifications as output, nor for software production nor for audio visual media production.

Due to the complexity of learning material and the development process there is a growing concern for support and help facilities. A distinction can be made between guidance and prototyping.

At this stage guidance is either available through pre assembled frames or units of learning materials. Expert systems or expert systems shells offer an even more elaborated facility for concern. The latest are however seldom applied except for ITS development.

Rapid prototyping can be regarded as a method to support the design process. As such authoring systems can be used for general prototyping purposes for not to complex applications.
In general facilities for (rapid) prototyping are lacking, although generic applications can be used for:

- windowing/user interface simulation;
  egMOSAIKK, Xrlib, InterViews, ANDREW (IBM - multiple windowing), CLUE (Common Lisp User Interface Environment, portable X-windows), MOTIF, Open Look interface styles.
- data prototyping.
  egDBMS, hypermedia and expert systems

.i.Technical Design;

Most development environments automatically translate designs into software code. As far as higher level languages and authoring languages are used technical design becomes relevant. Common practice is based on software engineering techniques and no formalised methodology dedicated to learning material development is available. This especially creates difficulties for highly interactive systems and multi media development.

4.5.2.3. Implementation and Distribution

Implementation is either taken care of by authoring systems or high level languages (PASCAL, C, SMALLTALK) and authoring languages (Eg. TenCore, TUTOR, PILOT, COURSEWRITER). Authoring systems are very efficient in terms of implementation, but show an overall lack of flexibility, especially with regard to different hardware configurations and multi media integration.

High level languages are very flexible, but require high expertise. Efficient production depends strongly on the efficiency of software libraries.

Many authoring languages are available. Identified trends are the incorporation of data standards (ASCII, GKS, PHICS, ODA/ODIF, POSTSCRIPT) and multi media integration facilities (Audio: AUDIOTEXT, AECAL; Graphics: AGRAPH, ENGOL; Multi Media: TenCore, Sony View System, PASS).

For multi media production (audio, video and optical media) a range of high professional facilities is available. Especially editing facilities are very elaborated. There is however a need for tools preparing production in terms of scenarios, shooting lists and editing manuals.

A limited set of optical media development tools is currently available (Eg. CD-SIMULATOR and Publisher, SCRIPT SYSTEM (PC), MAC TRAC (MacIntosh) and THE INFORMATION FACTORY (SUN/SPARC) for CD-I and the DVI Development Kit for DVI.

For media integration a limited set of tools is available and actually used at this stage. The Sony View system incorporates a extensive set of multi media editing and integration facilities. Other systems (Eg. MIC overlay systems) use non standardised graphical data structures and are not compatible with generic applications.

4.5.3. Requirements and Options

Overall there is a lack of facilities for providing adequate documentation.

4.5.3.1. Analysis

Further development of formalised methodologies and tools. Special emphasis should be put on tools for modelling and tool integration. Existing tools are method dependent and require more flexibility. Control mechanisms (consistency, completeness, correctness etc.) are especially required for domain modelling.

4.5.3.2. Design

As such there is a lack of formalised methodologies and standards have not been evolved. One identified option is the harnessing of software engineering methodologies in the area of conceptual modelling, iterative design, dialogue modelling and multi media specification. A second option is the further development of full size and flexible authoring systems. These systems should incorporate a range of facilities supporting instructional, functional and technical design activities.

Due to the increasing complexity of learning material, special attention should be given to distributed or collaborative working. Different experts have to be able to work together and (multi media) material have to be distributed and accessible on-line.

Efficiency can be gained through means of decision support and rapid prototyping facilities (especially for highly interactive and multi media applications).

The development of facilities for the production of technical documentation is neglected but highly relevant.

4.5.3.3. Implementation and Distribution

A wide range of requirements can be identified:
- facilities for collaborative/distributed working;
- methods and tools facilitating portability and interoperability;
- tools and facilities supporting transfer of learning material to different language;
- tools and facilities supporting re-use and integration of multi media material;
- communications facilities

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4.6. COMMUNICATIONS

4.6.1. Statement of the Issue

For flexible and distance learning not only communications between learners, tutors and producer, but also the acquisition, storage, processing, retrieval and representation of information and learning materials are becoming increasingly important. In particular the creation of a European market will be based on cost effective communications services.

The new ISDN networks will soon offer opportunities and integration of services, especially for distance teaching, to a degree even greater that can be imagined today.

The different Telecom Wideband facilities available in term of technologies are the following:

- Terminal **techniques** (Including LAN) will cover all Computer data networks, telematics and all the user terminal environments (Telephone, visual display, home computer etc).

- Transmission will include Optical fibre links, satellites and cable TV.

In fact the concept of ISDN will mix different technologies inside each sector and will integrate the transmission and terminal notions.

4.6.2. Description, Status and Trends

4.6.2.1. Terminals

Workstations are developing into multifunction terminals that include voice, data, fax, videotext and interactive video services etc..

Multimedia terminals will soon emerge, especially with the advent of ISDN.There is a growing demand for integrated equipment which can handle several different services at the same time.

For more than 10 years, terminal technology has improved considerably, and it is now possible to find a very flat screen with good resolution suitable for training purposes as a learner teacher station.

This technology also includes video projectors or large flat panel displays which enhance long distance videoconferences allowing a large number of trainees to follow distance training (Interactive or not).

Facsimile and telex machines as part of the workstation can be reached through the PC and data network.

Data networks (packet switched networks for example), which allow communication between computer and remote terminals have been developed.

Recently more user-friendly networks, such as videotex, have become available. In France more than 5 million minitel terminals (Videotext technology) are available, offering over 10,000 services. The use of the minitel can be seen both as an operations and general information system and as a training device.

Distance training through videotext is used by France Telecom for the training of their employees at their workstation (desk). The workstation is simply equipped with an extra Minitel which can also be used for other purposes such as consultation of databases The training given is technical, but appears more like a work than real training by computer. This system is also used for teaching languages to beginners, especially writing skills.

Only a few other examples of telecommunications applications in the educational field can be identified. The Open University extensively uses Ethernet for administrative purposes on campus and to connect the regional centres. Until recently only a few courses have been based on computer conferencing.

Local Area Networks have been quite successful. The number of LANs in the US had grown to 423,000 by 1987 and was predicted to double again within two years. There is a trend to connect geographically separated LANs through bridges operating at 1.5 or 2 Mbps rate. Future ISDN and developments in fibre optics will allow for interaction between LANs and ISDN.

In industry LANs are mainly used for monitoring and administrative purposes.

Various DELTA, ESPRIT and RACE projects are trying to improve the use of these techniques by permitting flexible configurations, and using standards adopted by the European countries.

4.6.2.2. Transmission Techniques ISDN

At present industries are developing the Integrated Services Digital Network (ISDN). ISDN will offer a widely dispersed service with voice, data, text and fixed or half moving pictures communications. Initial services will be based on narrowband (64 Kbps Basic Rate Access) offering speech/data transmission.

In the early 1990s broadband networks will become available offering access rates from 2Mbps up to 140 Mbps which will allow intensive moving pictures and TV transmissions.

4.6.2.3. Optical Fibres

Optical fibre links are already operating at 140 Mbits in most of the European countries, and it is hoped that in the near future a rate of over 500 Mbits(Equivalent to 8 000 simultaneous telephone conversation) will be achieved. At present these fibres are used mainly for trunk communication networks, but experimental work has given the opportunity of linking termination equipment. In fact the real interest of Wideband cable is that it will allow the introduction of a whole new range of services as optic fibre starts to reach into the office and the home.

The Biarritz optical network in France includes the linking and the switching of the broadband communications by use of an opto-electronic switch. This system allow each subscriber to reach simultaneous services in an interactive way :

- Access to a video bank (50 000 possibilities) for 2 simultaneous programmes,
- Videotelephony

- Videotext (Minitel)
- Radio programmes (30 Channels)
- Normal telephony (Voice)

These facilities can be used for training at home. The ESPRIT project (HOME SYSTEM) is an application of this service.

The introduction of Wideband capability into the switching network makes video-comunication a technologically viable option. Videoconferencing involves 2 or more specially equipped studios linked for transmission of voice and picture.
Most of the equipment now uses the 2 Mbits network (Slow picture) It is possible to organise multivideo conference with an automatic videoswitch using the voice as the switching signal.

By using high speed (140 Mbits) it is possible to get a good quality picture more suitable for distance training.

Two interesting experiments have been undertaken:

- The London University using a 140 Mbps connection for two way video conferencing in medicine.

- France Telecom using, for the distance training between the Caribbean and Europe a special network for interactive video conferencing. One way (from the teacher) uses 140 Mbips, and the second way (from the trainee) uses 2 Mbits. This configuration allows multilingual users simultaneously and up to 4 different training locations. Very sophisticated pedagogical tools such as computerised pictures, Digital effect etc, can also be used because of the good quality picture obtained.

Different DELTA projects such as LAT, OLE and OLEW are experimenting with the use of videoconferencing as a media for distance training.

4.6.2.4. Satellite Transmission

Satellite communications offers broadband diffusion from one point to all places where adapted receivers are installed and are also used for long distance link (Point to point).

Most of them give broadband facilities as they are working in the field of 6/4 Ghz and 14/12 Ghz. As an example a new generation satellite has a capacity of more than the equivalent of 80,000 voice channels or 2,500 "2 Mbit" videoconferencing channels

The increasing frequency band and higher amplifier power allows the use of smaller receiving antennae.(0.6 meter in diameter for receiver). This has a direct effect on the price and volume of home use.

A large number of satellite have been launched or are being planned at present.

SATELLITE SYSTEM IN EUROPE

Satellite	Organisation	Launch	Services
Telecom 1	France Telecom	84	Videoconf * Tel
Kopernicus	Deutche Bundes	89	Tele Data TV Videoconf
Italsat	Telespazio	90	DBS Norm Comm
Tele X	Swedish Space Co	89	DBS Videoconf
Olympus	ESA	89	DBS * Busin Sces
I-F4 F5 II-F1 etc	Eutelsat ---	88 90	Telep Data TV ----
TV-SAT2	BMFT/Deutch Bund	89	DBS(Hght pwer)
TDF-1	CNES TDF	88	DBS(Hght pwer)
BSB	UK Sat Broadcast	89	DBS(Hght pwer)
Astra	Ste Eur Sat	88	DBS *(Med. pwer)
Atlantic	Atlantic Sat	89	DBS Channels
Hispasat	Hispasat SA	92	DBS

*** Use for training**

As shown in the previous table, 3 of these satellites are used or are being used mainly for training. It must be clear that all of them can be used for this purpose, depending on the policy followed by the user company.

Satellite communication is especially valuable for multi-lingual broadcasting of courses. EuroPace is delivering training courses through DBS, and furthermore within the DELTA Exploratory Phase several experiments have been initiated using the ASTRA satellite.

Besides these projects, the association of the users of the Olympus satellite (EUROSTEP) promote this type of distant training.

Overall broadcasting is applied through the national channels.

4.6.3. Requirements and Options

ISDN will provide integrated services, data and voice transmission, electronic mail, videotex or image transmission. As such the technologies offers excellent opportunities for flexible and distance learning.

It is not necessary to develop new networks specifically for educational purposes. Existing and future networks will provide all the required communications facilities. Nevertheless some requirements can be identified:

- services, such as multi language user interfaces and standard protocols, facilitating usage by non-specialists;
- services facilitating trans-national usage of ISDN ranging from on-line user guidance in the appropriate language to real-time interpretation integrated into multi media conferencing systems;
- services providing for pricing, accreditation and certification;
- measures in the area of data integrity, security and confidentiality;
- development of information resources applicable in the educational field;
- stimulation of wide networks of users.

ISDN is very well adapted for educational applications due to its transmission capacity and the European standardisation. Applications should be developed at different levels of sophistication, investigating the use of both low level (narrow band) and high level (broad band) usage.

Applications should be based on existing and future communications facilities such as:

- wide area information services
- image transmission, with high resolution and error free transmission
- electronic mail and computer conferencing
- satellite based two way broadband communications

These applications should result in increased 'know how' and experience in the specific thresholds and requirements for education and training. It is essential that these applications take into account the existing standards and protocols as specified by organisations such as ISO, CEN/CENE/EC, ETSI, CEPT and ITU.

4.7 INFORMATION ENVIRONMENTS

4.7.1. Statement of the Issue

Flexible and distance learning will more and more depend on the availability of information and learning material resources, such as centralised or generic multi media databases and on-line access to distributed resources.

The development of learning materials will be increasingly based on the incorporation and transfer of existing materials, while learning will depend more on the direct access of distributed information and learning material resources.

4.7.2. Description, Status and Trends

4.7.2.1. Information and Learning Material Resources

Recent developments in flexible and distance learning show an increase in the usage of multi media databases. Up until now, applications (Eg. DOOMSDAY) have been based on video disc, containing generic image bases and integrated in specific courses. Indirectly linked to education are encyclopedia becoming available on optical media, Eg. GROLIER ENCYCLOPEDIA on CD-I and COMPTON'S MULTIMEDIA ENCYCLOPEDIA. Overall however the use of multi media databases or on-line information resources is very limited.

Multi media databases (locally or on-line) can serve different purposes in flexible and distance learning:

- a stand alone information resource for learners;
- a resource for dedicated learning applications and the development of new applications;
- a collection of learning material to be selected and presented to learners by ITS or human tutors.

Several storage devices are being (or will be in near future) applied for multi media databases.

- Video Disc is an analogue optical storage device providing over 50.000 high quality video still (or 35 minutes interactive full motion video) and 2 audio channels.
- CD-ROM (about 600 MB binary data) is the only wide-spread medium for electronic publishing of information and based on accepted standards. CD-ROM is not suitable for multi media data storage due to lacking compression schemes for audio and video.
- CD-I will offer 4 audio levels, 4 still video encodings and full motion full screen video, in addition to text, graphics and data.
- CD-ROM/XA (eXtended Architecture) incorporates audio and graphics standards of CD-I.
- CD-WO (Write Once) is derived from CD-ROM /CD-Audio and will in the (near) future offer a low-cost multi media mass storage device in a low-end workstation environment. A wide variety of WORM (Write Once Read Many times) systems is available (Eg. Sony LVR 6000, storing 72000 analogue video frames)
- DVI (Digital Video Interactive) is a digital video compression scheme, offering full motion video, audio, graphics and data in a dedicated MS-DOS environment.

- magnetic storage devices are becoming more and more relevant for multi media storage, due to the high storage capacity (over one Gbyte) and access rate. At this stage no standard appropriate compression and decompression techniques are available for full multi media applications.

As such there is extensive discussion whether optical storage will become the future de facto standard technology for storage. At the moment however magnetic storage as well as optical (or magneto optical) storage serve different functions. Magnetic storage (hard disk) has the advantage of very high speed and low price, while optical storage allows for a higher data density and is less sensitive to deterioration or contamination. However performance of optical storage is about 25% of hard disk performance and major changes are not expected over the coming years.

New developments are oriented at rewritable optical storage with direct overwrite capabilities, which would increase performance substantially. Another interesting development is digital optical paper, offering very large storage capacity (BOSCO 5 1/4 offers 1 GBYTE) with high average access time (40 ms) at low cost.

As far as DBMS are concerned learning applications are mainly based on traditional database techniques (hierarchical, networked and relational data models). However these traditional DBMS' are not suited to modelling complex entities such as texts, images and sound and motion video. Recent developments with important functionalities related to educational usage are semantic data models and object oriented DBMS (GEMSTONE, VBASE) and derivations such as HYPERMEDIA.

4.7.2.2. Distributed Resources and On-line Access

Development of information and communication technologies will stimulate a growing number of distributed on-line information sources related (DIANA, TELETEL, PRESTEL, ITAPAC) or dedicated to learning.

A limited number of on-line accessible databases has already been developed to enable the user (Ie. learner, author) to connect, locate and download appropriate clusters of information from these sources.

In the domain of learning materials or of educational software, information resources may include catalogues, products (the courseware itself, or an information module on a specific topic) or samples (demonstration subsets, executive summaries, etc.).

In several European countries, the on-line European Learning Resource Directories have been developed but they are for local, regional or national use and rarely compatible with systems developed in the other countries. (In United States, the ERIC database has become one of the most extensive source bibliographical information on education and training.)

None of them has been given the multi lingual features and other "help" facilities, which already exist in other fields, such as scientific and technological information.

Complementary to telecommunications facilities and services, some added value services relevant to flexible and distance learning are under development.

Tele-video-library Service

This essentially offers an on-line service similar to that of videotape rental. Subscribers can select video (TV) programmes and decide on the time of transmission. One experiment in US with custom video covering 200,000 subscribers has been established. British Telecom will set up an experiment with 40 subscribers and in France the Biarritz network has been established serving 1200 homes and 300 businesses. Although these experiments address mainly leisure and amusement the technology and methodology involved is highly relevant for educational purposes.

Audio-videography Service

Provides continuous interaction with image banks. Natural image requires a minimal 64Kbs access rate. Photographic images could be displayed on an alpha-geometric videotex terminal.

Electronic directory service and broadband videotex offering broadband two way communications services.

4.7.3. Requirements and Options

4.7.3.1. Information and Learning Material Resources

Requirements can be defined on two levels:

A wide range of suitable storage devices (and complementary interfacing) suitable for multimedia databases is available. Overall problems exist with regards to storage capacity, standardisation in multimedia data structures, compression and decompression techniques and D/A conversion.

- overall CD based devices have limited capacity and are not re-writable (a standard CD-WO is not expected to substantially penetrate the educational market within 5 to 10 years). Data structures on CD-ROM are not standardised, which creates portability difficulties. Furthermore D/A conversion techniques are not standardised and have limited (with a few exceptions) capacity (available D/A conversion goes at the moment up to 3500 Hertz).
- for DVI the required quality level for compression / decompression of motion video is under development;
- video discs are limited to analogue data and show lack of standardisation in the area of interfacing and overlay systems;
- alternative storage, such as very high density magnetic storage (Eg. SMART-CARD), provide no standard for multi media data structuring and compression/decompression technology is not suitable yet.

Information Representation and Retrieval

State-of-the-art DBMS technology is quite suitable for multimedia based learning applications. Several requirements however can be identified:

- the development of agreed standards for multi media indexing and retrieval;
- advanced query, navigation and browsing mechanisms (key-image indexing; content, image and context based retrieval);

- facilities supporting users in database access, search and retrieval. In the immediately following generation of databases, access will be implemented by query languages approximating to natural language, and to some extent by query by content. This development will need to be harnessed to the needs of learners, with, in addition, artificial intelligence (AI) aids (Eg. specialised representation of knowledge in frames, scripts and semantic nets; means for modelling user goals and intentions in terms of information given by their previous dialogues with the relevant systems) which help both to interpret the learner's enquiry and also to improve the relevance of the information retrieved, both in quality and in quantity, eg. the level of aggregation;
- facilities to generate personalised database and to manipulate multi media and distributed data.

4.7.3.2. Distributed Resources and On-line Access

Different types of added value telecommunications services are required for flexible and distance learning.

Future flexible and distance learning will be based on a large quantity and variety of information artifacts potentially available and required by the actors in the open learning environment.

Currently, access to different sources and types of information is fragmented, confusing and not user-oriented. There is a need for a universal virtual library comprising all appropriate resources accessible to the user by (near) natural language queries. Retrieved information should be susceptible to restructuring as a personalised database. Specific requirements identified are:

- intelligent intermediary, such as an intelligent, expert system based front-end to allow natural language access to information retrieval systems as opposed to the current complex access to on-line search systems via specialized command languages;

- meta-resource base which includes references to all appropriate sources of knowledge, information and data;

- meta-languages which are those representational languages or means of formally representing the contents of information artifacts. They would include thesauri, indexing schemes, classification codes, conceptual graphs, semantic nets etc.;

- specification, representation and manipulation of large distributed multi media databases with a focus on intelligent database access. Other areas of interest will include transportable natural language interfaces, 'forgiving' query-languages that both interpret the user's intended query and even generalize its scope, and knowledge-based semantic query optimisation techniques;

- an user support system dealing with communication between different systems, multiple language access, downloading/uploading, data conversion and transformation, multiple window access to an information base, navigation inside menus and modules, developed display technologies and image techniques;

- tools for monitoring and analysing quality and quantity of information and distributed on-line database usage;

- local (organisational) and central (national, European) providers of training connected through the use of advanced telecommunications and the integration of public access information networks with local area networks;

- facilities and methodologies for controlled access, data protection, privacy, encryption and charging.

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4.8. TRAINING SERVERS

4.8.1. Statement of the Issue

Extensive flexible and distance learning requires integrated systems and facilities enabling multiple user interaction and local or remote communications between human actors and information resources.

These systems are based on hosts connected with on-line terminals which provide specific services based on training and education requirements for different actors (learner, human tutor, monitor or administrator).

4.8.2. Description, Status and Trends

Training servers are supposed to provide an integrated networked systems configuration incorporating services for:

- central (generic and personalised) multi media storage;
- local and remote communications, based on different band widths and multiple actor interaction (file transfer, mailing, conferencing [computer, audio, video], terminal emulations, dial up services);
- dedicated interaction services, such as help services, ITS, human tutoring and monitoring;
- centralised administration, such as accreditation, assessment, certification and accounting.

At this stage no training servers providing a wide range of integrated services as described above have been developed, although subsystems and related services exist.

In the information market extensive experience has been gained with networking and on-line/off-line remote access of resources. Dedicated configurations have already been developed. For example, videotex hosts have been specified to fit the requirements of pay information services. However there are few specific functionalities on the system. The telephone or the assistance of a printed handbook supplement the lack of easy interactivity on the network.

Computer conferencing has been established as a widely used communications method. Several examples of educational usage occur, such as the ETHERNET system at the OU (UK), the University of Alaska Computer Network (UACN), the Knowledge Network in Canada (computer and two way video conferencing). Overall these applications make usage of proprietary systems.

Help and guidance systems are being developed within dedicated courseware applications. On systems level only a few supportive facilities (Eg. EUROHELP) have been developed. Limited examples of ITS are available and only a few have actually been applied. In research there is a trend towards domain independent systems.

Monitoring and administration is still an underdeveloped area. Monitoring as methodology is applied in individual applications and overall is restricted to record keeping. More advanced techniques such as error diagnosis and multiple actor monitoring are applied occasionally. Research and development on assessment, evaluations and eg. item banking for testing is not well integrated in the overall area of flexible and distance learning. Few examples exist, especially at US universities, where evaluation techniques such as item banking and automated test generation are applied and incorporated in the learning environment. Administrative facilities as far as they are available in flexible and distance learning are in general not integrated and are based on general purpose applications.

4.8.3. Requirements and Options

As soon as flexible and distance learning is applied extensively, serving a wide range of users, offering different education and training options and making use of networked and distributed systems a centralised facility such as a training server will be required.

Several options are available. Systems components and specialised services and techniques, such as information resource server, communication server, ITS, monitoring etc. need further development. There is subsequently a requirement for the integration of these elements, either in closed or open ended system. Different solutions can be perceived for home-learning and corporate-learning environments.

In several areas requirements can be identified.

Information Resource Server

This server would facilitate storage and retrieval of centralised and distributed information and learning material and would be linked to a communications server (see below). Required services woumd be:

- multi media storage and access;
- "local caching" downloading from remote hosts;
- provision of resource catalogues, directories and file management facilities;
- authentication, access control;
- personalised multi media storage;
- off line translation facilities and multiple language access;
- data transfer and conversion.

Communications Server (local and remote)

- virtual terminal emulations;
- connection to non local hosts;
- inter-personal communication (message transfer, conferencing, screen sharing);
- front-end development and standardisation;
- data transfer and conversion;
- standardised protocols and procedures;
- on-line translation facilities.

Dedicated Services

- collaborative dialogue facilities for the composition of messages, reviewing, cross referencing, indexing, addressing, transmission, storage, retrieval, history and tracing;
- coordinated set of MMI principles and facilities for eg. screen sharing;
- group decision support and priority rulings;

- **user support, such as dynamic task sharing, systems help facilities, multiple window access facilities, navigation support. In the area of AI and ITS especially technologies are being developed that could be integrated. This service should incorporate models for the state of understanding of individual users connected to the system, to determine their need and hence to allow automated selection of the procedures to be followed.**

- **human tutoring, requires firstly a range of specific communication facilities based on mailing, conferencing and screen sharing. Furthermore a human tutor requires facilities for monitoring (identification, tracking and assessment or modelling of learners), distributed editing facilities for adapting learning material, etc.**

- **administrative services are required for management and planning. Functions to be supported are related to accreditation, certification, evaluation and testing, sampling and delivering access to user statistics and data on system usage, accountingresource and capacity planning.**

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4.9. APPLICATIONS

4.9.1. Technology to Support Disabled People

4.9.1.1. Statement of the Issue

Disabilities of any kind. The lack of standards has led to the development of numerous incompatible products. Significant economy of scale could be achieved if a study of the needs, in particular on the definition of user interfaces for disabled, was to be conducted. Such interfaces have to be designed in such a way that will allow an easy adaptation of future courseware. In addition it must be emphasized that the handicapped have particular needs not covered in the general provisions of an educational and training system using ALT.

Special education differs from general education in that it is primarily concerned with preventative, compensatory and rehabilitation measures facilitated by the technology. Very little of the potential of new technologies has been investigated and exploited for special education of both children and adults.

4.9.1.2. Description, Status and Trends

It has become accepted that a disabled person with adequate equipment can achieve very good productivity and will be very motivated. The rapid pace of technology creates new opportunities on a nearly daily basis for persons with disabilities.

Currently the following disabilities are catered for:

- *Vision Impairment*

Tactile reading terminals : Braille displays make the workstation available for use by the blind. They consist of a Braille display module that shows, line by line, the information that appears on the screen. The optical to tactile converter reproduces the shape of the characters on the screen. Audio systems also permit the blind to hear what happens on the screen. When linked with an application, it automatically watches messages sent by the system. In addition Braille printers are becoming available on the market and, simple screen magnification techniques can be used by non totally blind persons. Audio conferencing offers a good opportunity for the training of blind people.

- *Hearing Impairment*

Due to the visual orientation of learning technology it offers a solution for a wide range of training needs of hearing impaired. Class room teaching creates difficulties in understanding what is "said", although sign language is in many instances appropriate. Self study based on printed material also has it limitations for hearing impaired. Learning technology can however bridge the gap between classroom teaching and printed learning material. Specific use of learning technology can be found in speech reading training. Using interactive moving video excellent training facilities can be created, that otherwise are very difficult to realise.

- *Speech Impairment*

Advanced Hardware and software development allows the treatment of speech disorders. Visual feedback enables speech therapists to motivate patients to control dimensions of speech such as pitch, volume and timing. This technique can be used 'life long' by deaf people to monitor the quality of their speech and contribute to the quality of their social lives. Again for speech impaired learning, technology offers excellent solutions in the provision of education and training that normally would be difficult to provide.

- *Mobility Impairment*

Voice recognition technique will allow spoken utterances to serve as input to a computer for persons unable to access the keyboard. Some other keyboard emulating interfaces have been designed to take into account the wide variety of mobility difficulties, such as the "Concept Keyboard". Telecommunications particularly can make learning opportunities available at home for the mobility impaired, by means of on line tutoring and the access to information/resource bases.

4.9.1.3. Requirements and Options

To allow disabled people to fully benefit from the ALT developments and use, the following approach is proposed:

- promote information about existing experiences on the use of ALT for disabled;
- establish an information network about products and projects;
- adapt existing materials to the particular educational styles, cultural differences and level required by special needs categories;
- promote innovative use of ALT to support disabilities hardware and software;
- standardise the user interface to include 'drivers' for additional devices needed to help disabled person to fully access the computer and to allow easy adaptation of future courseware to the disabled needs;
- specific attention should be given to pilot projects investigating the application of telecommunications and multi media for disabled people. These pilots have to concentrate on the linking of groups of people, identification of appropriate media and related technologies.

4.9.2. Language Learning

4.9.2.1. Statement of the Issue

Language learning is of major importance for the European community in developing increasing coherence in all aspects of public and private life. The creation of the "internal market" will confront not only international companies but also to a large extent SMEs with a greater need for a multilingual staff. This implies the need for more efficient and adapted language training facilities. Computer assisted language learning (CALL) approach can give an important added value to existing language and training courses. The new technologies have profound implications for educational activities and will bring into question quite fundamental notions such as the nature of the curriculum, the language teaching methodology, the role of the teacher, etc. Due to the very nature of language learning, some specific tools and methodologies are required. This make foreign language learning a strategic choice to harness and pilot test existing and future education technology.

4.9.2.2. Description, Status and Trends

In the area of language, extensive linguistic research is being conducted and this has already produced a good understanding of the underlying learning principles. This has resulted in many research and learning applications in this field, varying from conventional training programmes to sophisticated research projects incorporating AI.

In many schools there are sophisticated language classrooms with a wide range of audio equipment and broadcasting organisations (UK, the Netherlands) are providing language courses through national television channels on a regular basis.

Furthermore a fast growing number of computer based and multi media based learning programmes are becoming available. These applications vary from fundamental and basic language skills in primary education to high level foreign language training courses, even addressing cultural issues. In many instances these applications integrate interactive video presenting native speakers and giving practice on understanding and pronunciation.

By means of learning technology a wide range of individualised learning material can be made available, offering self paced learning, with excellent audio visual presentations. These applications can vary from drill & practice to surrogate travel and interactive narratives.

Using linguistic knowledge on grammar, syntax and semantics and language learning as such, it is possible to monitor closely and diagnose learning performance and to give in depth guidance and remedial feedback.

Sound synthesis is not applied, because the quality of artificially generated speech is not appropriate for language learning. Also the usage of CD-ROM creates difficulties because the performance (in term of hrtz achieved) of available D/A converters is not appropriate. CD-ROM XA, CD-I and DVI however provide appropriate functionalities.

Limited experimentation on speech recognition and analysis for pronunciation training is done.

In the domain of language learning several technology oriented trends can be identified.

- Increasing processing power in computers and advances in AI result in very sophisticated applications, based on very elaborate diagnostic techniques.

- Multi media storage devices (video disc, CD-ROM XA, CD-I, DVI) are integrated to provide audio and video presentations.

- In the area of speech recognition and synthesis progress is being made, although not to the level where it can be widely used for language learning.

- In the area of telecommunications, DBS and broadband networks provide adequate functionalities for multiple language broadcasting and video conferencing for language learning.

4.9.2.3. Requirements and Options

The available knowledge on language learning, the progress in appropriate technology and the critical importance of language learning for Europe make the domain highly relevant for pilot applications of emerging technologies.

Pilot applications can have two orientations:
- language support facilities;
  for producing multiple language learning material and within specific learning application;
- language learning applications.

Language support facilities
In the area of learning-material production (especially for a European market) as well in the learning applications themselves, tools for the interpretation and production of texts or speech in different languages are required. Pilot applications should focus on the integration of automatic translation facilities, support facilities such as on line dictionaries and Thesauruses, and spelling and syntax checkers. AI techniques for language parsing and synthesizes should especially be considered.

Language learning pilot experiment.
The application of new technologies in language learning can only be justified by an increase in didactic efficiency. This increase can be achieved by taking full advantage of firstly the interactivity of the computer and secondly multi and interactive media technology. Interaction through the computer allows for: immediate error analysis, automatic generation of remedial material, and last but not least making the system adaptable to the needs and the natural learning pace of the end-user. This last requirement can be translated into the need for a rich, well structured lexicon database based upon studies on the frequency of use and based on careful and explicit systematisation of the vocabulary in different learning environments. This means the system should be able to be easily tailored to meet some specialised needs like acquiring proficiency in commercial letter-writing or the learning of the specialized vocabulary used in information technology.

Multi media technology offers excellent opportunities for the provision of real life training simulations. This provides an unique opportunity for language learning, whereby the learner can explore, apply, hear and see a considerable amount of examples and exercise. Multimedia technologies are likely to improve didactic efficiency by allowing the student to repeat a video sequence, ask for subtitles, look at a dictionary etc ; this improvement has however to be measured and related to the price increase of the workstation.

From the software engineering viewpoint CALL is likely to generate some specific requirements which can eventually be included in DELTA's PETE, especially in the field of database organisation, retrieval of contextual information, speech synthesis and recognition.

Special tools like the automatic adaptation of text to a predefined level of lexical difficulty may lead to interesting applications in others fields.

4.9.3. Collaborative Learning

4.9.3.1. Statement of the Issue

Developments in telecommunications and the increasing availability of infrastructure for communication can be applied to collaborative learning. Collaborative learning is not only a way to overcome the isolation of distant learners, but is also considered an effective learning strategy as such. Although IT&T provide the general functionalities for collaborative learning there is a need to harness and accommodate the technology to specific educational requirements. Pilot testing collaborative learning applications based on general and dedicated telecommunications technologies are especially required.

4.9.3.2. Description, Status, Trends

Collaborative learning could be defined as learning through and with peer group learners. Collaboration depends on the possibility for learners to communicate with each other and to receive support (machine-, human tutoring and monitoring).

By means of telecommunications and on- and off line information resources collaborative learning can be established.

Only a few examples of collaborative learning can be identified at this moment. Most applications are being realised in the USA and Canada, eg. the Rochester Institute of Technology (New York) uses computer conferencing to permit distance learners to "attend" discussion classes.

Since 1985 the Connected Education computer network of the New School for Social Research (USA) has offered over 100 MA courses worldwide entirely via computer teleconferencing. Another example is INTELENET in Indianapolis (USA). INTELENET is a communications network linking 16 to 34 sites through optical fibre cable, providing data and voice communication and video broadcasting services for education.

In Europe the OU (UK) provides computer conferencing for students, offering conferencing and E-mail facilities. Minitel is occasionally being applied to learning.

These experiences show that collaborative learning and on line tutoring can be very effective and serve specific educational requirements. Collaborative learning is especially suitable for on-line role-playing and simulations. Examples of peer group management training in corporate environments have proven to be very effective.

Moreover collaborative learning can be a very effective way to decrease the isolation of distance learning and to increase support during learning activities.

There is a clear trend away from purely e-mail based applications towards computer conferencing.

4.9.3.3. Requirements and Options

Based on existing technology collaborative learning already can be put into effect. Nevertheless developments in general purpose technology require a constant updating and harnessing for educational usage. Furthermore dedicated facilities and services for educational usage of telecommunications is required.

Facilities for on- and off line tutoring, local off line facilities for learners to prepare messages, process and store information and user friendly front-ends to general purpose telecommunications services are particularly needed. Also multiple actor dialogue facilities and management approaches should be considered, such as available techniques for:

- the composition of messages, reviewing, cross referencing, indexing, addressing, transmission, storage, retrieval, history and tracing;
- group decision support and priority rulings;
- user support, such as dynamic task sharing, system help facilities, multiple window access facilities, navigation support.

Pilot applications should give insight into the potential usage of computer networking for collaborative learning. What subjects are suitable, what local support is required and what type of communications facilities are available to create effective collaborative learning.

4.9.4. Exploratory Learning

4.9.4.1. Statement of the Issue

Increasing on line and off line availability of information resources allows for new approaches in learning, eg exploratory learning. Exploratory learning can be defined as a way of learning by which a learner with limited guidance explores information resources in order to acquire knowledge and experience. Exploratory learning is based on the extensive usage of advanced information technology and telecommunications services and is very well fitted to test pilot applications of advanced learning technology.

4.9.4.2. Description, Status and Trends

Exploratory learning as such is being applied in traditional education. LOGO has been the most inspiring approach to exploratory learning over the last few years. New technologies such as hypermedia and multi media databases (Eg. Doomsday Disks) provide the technical functionalities for exploratory learning.

Exploratory learning depends on the availability of an information resource that covers the domain in terms of completeness as well as in detail. Technological developments in the area of database management systems and storage technologies provide the appropriate functionalities to create these information resources.

A range of hypermedia systems is becoming available on the market and much attention is given in the educational field. However only few applications are actually being used.

After the first excitement on the possibilities of exploratory learning, experience has shown that full learner control does not result in optimal learning results. Guidance of the learner on the learning processes is required.

Research concentrates on navigating in large multi media databases and support mechanisms for the learner.

Exploratory learning applications available at this stage are based on stand alone information resources. However on line databases can be applied to this learning approach, eg. Minitel and complementary services provide a wide range of information services that could be harnessed to educational needs and serve for exploratory learning.

The SMART Library project in Canada is an initiative of the Ontario Ministry of Culture and Communications, and aims to link libraries and information sources for educational usage and to provide tools to gain access to electronically formatted multimedia information. The SMART Library is intended to be a kind of information supermarket featuring 100 workstations.

4.9.4.3. Requirements and Options

Exploratory learning is considered to be a powerful learning strategy provided appropriate information resources are available and sufficient guidance is provided. Further developments and pilot applications are required on several aspects:

- the creation of extensive multi media databases providing effective navigation and search facilities is still a very complex exercise and requires R&D to support and optimise the development process;

- research on guidance and support mechanisms for goal oriented and efficient exploring behaviour with learners;
- while learners are navigating through large databases they require facilities to document the traces they follow, to create personalised versions of the information resources and to store these locally;
- more extensive exploratory learning environments will be based on a range of different information resources. Further development is required on distributed management systems for educational usage;
- related to the previous issue, research and pilot testing on linking different kinds of information resources (in terms of data structure, media and hardware) is required.

4.9.5. The Use of Simulation and Modelling in Learning

4.9.5.1. Statement of the Issue

As previously stated computer based simulation is one of the most promising learning environments. Although simulation can be used in a wide variety of environments, its contribution to a better insight is invaluable when applied to dynamic systems difficult for the student to understand and for the teacher to present whether the subject be environmental systems, economic activities or hydraulic circuits. In some instances the use of simulation is the only cost effective way to teach. Vocational technical education is likely to benefit most from that approach. In order to better understand the critical success factors a reasonably large scale pilot project is needed.

4.9.5.2. Description, Status and Trends

Simulation is playing an ever increasing role in research and development. Consequently expertise and products are becoming available. Until recently simulations that used sets of partial differential equations to describe models ran on high performance computers; advances in algorithms combined with the increase in power of PCs make the technology available on low cost workstations and applicable for education purpose.

To be effective a simulation has to be connected to an adequate learning environment. The minimum requirement is the link between a classical CAL program and the simulated model to guide the learner in the exploration and understanding of the phenomenon investigated. The ideal environment should, in addition, contain facilities to analyse and interpret the learner's reactions. It must deal with the logic of the developments of events in the simulation and with learning performance and must be able to set the level of interaction and of the learner control : the simulation. based learning environment is a discovery environment, learners should be able to carry out their own experiments, to work on the solutions of problems and to navigate through the system.

Some products are just appearing on the market: SIMCAI (SIMulation and CAI), MOSAIC running on IBM PC and compatible, STELLA running on MAC.. SIMULATE which is part of the SAFE project should imbed simulations in an intelligent tutoring environment.

The current trend on the use of mathematical models in teaching is to go beyond the simulation activity and allow the learner to modify or even create the model. Another trend is towards the simulation of complex systems which require large knowledge bases. A large amount of research is being carried out on knowledge representation and management of knowledge bases containing multi-media informations.

4.9.5.3. Requirements and Options

Development of a prototype of a simulation based learning environment based on the current work on techniques for design of complex real-time simulation based learning environment. This prototype should concentrate on the training needs in technical vocational education. The simulation system should incorporate:

- Tools to develop mathematical and stochastic models

- Tools for acquiring expert knowledge on the behaviour of the model in order to help the student at any time while allowing him free investigation of the model. Common 'misknowledge' should also be introduced.

- Tools to represent the system and its behaviour in graphical and animated form.

- Tools to acquire data from real life experiment in order to allow the student to validate its own models.
- Tools and methods to measure the didactic efficency of the learning process.

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5. POLICY AND PLANNING

5.1. REGULATORY FRAMEWORK

5.1.1. Statement of the Issue

The various regulations which govern the market conditions and use of ALT can either inhibit or encourage their uptake. The current regulatory regime, in some important aspects, is more likely to inhibit than promote ALT.

The following are the areas in which regulations are perhaps most critical:
- copyright to protect the interest of multimedia and software producers;
- legislation which confers monopoly rights over the provision of telecommunications services;
- broadcasting regulations.

These latter are national in character and impose no social obligations on transnational broadcasters. Traditionally in Europe national media legislation imposed an obligation on national broadcasters to "educate and inform".

5.1.2. Description, Status and Trends

5.1.2.1. Introduction

The problems of regulation in all three critical areas are currently under review by international bodies, particularly the Commission of the European Communities. Copyright is the subject of a Green Paper and continuing negotiations in the Member States; the Commission hopes to complete its plans for copyright protection of the author's rights in the area of satellite and cable broadcasting in the course of 1990; the PTA monopoly over telecommunications services is under review in most of the Member States; broadcasting regulation is the subject of an E.C. Directive "Broadcasting Without Frontiers" (October 1989) which creates the conditions for a European audiovisual "space". As training and education have not been given a high enough profile in these discussions, the content of proposed international agreements is therefore not as relevant as it could be.

5.1.2.2. Copyright

The Green Paper "Copyright and the Challenge of Technology - Copyright Issues Requiring Immediate Action" (Com 88 172) was published in June 1988.

The Green Paper points out that in the industrialised countries there has been a shift away from the production of goods which have the character of "staple commodities" to goods and services which have as their principle characteristic the application of technology, skill and creativity. These attributes constitute the main competitive advantage of the goods. This is also true of training and educational services which, increasingly, are offered for sale in the commercial market place rather than in State subsidised institutions.

The arrival of multimedia technologies makes the protection of multimedia products of primary importance. Multimedia production is affected by copyright legislation in two crucial aspects.

First, there is the issue of component parts within multimedia goods. In order to produce multimedia goods in the most cost effective way, it is necessary to be able to 'source' the goods from existing audio-visual material. If it was necessary to engage in the original production of audio-visual source material or every multimedia product, then the cost would be prohibitive, especially for the purposes of training and education. It is necessary, therefore, to protect data and image banks which multimedia producers may wish to draw upon.

Secondly, the finished product needs to be protected. Pirating and unlawful copying would be a breach not only of the contract between the producer and the consumer but also of that between the producer and the component supplier.

In order to stimulate a single European market in multimedia products, and hence reduce the cost of multimedia products to the training and educational community, it is important that the various elements of multimedia products come under one international agreement.

Some of these elements are at present protected at the international level under the Berne and Universal Conventions. Moving images, whether sourced from film or video, are protected under Article 14b of the Berne Convention. This provides the framework for the legislation protecting cinematography within all the Member States. The Convention extends protection to video by its definition of cinematographic work as "works expressed by a process analogous to cinematography".

Books and literary works are protected under the same conventions. All Member States are signatory to the Berne Convention which vests in the author the exclusive right to authorise the reproduction of his or her work.

The legal protection of sound works is less uniform. Neither the Berne not Universal Conventions require protection to be given to sound recording as such.

The 1961 Rome Convention on Neighbouring Rights (The International Convention for the Protection of Performers and Producers fo Phonographs and Broadcasting Organisations) offers protection in the form of a right for producers of Phonographs to authorise or prohibit the reproduction of their phonograph for a period of 20 years from first fixation. Not all the Member States ratified the Rome Convention.

A non-obligatory provision within the Convention gives producers and performers the right to receive equitable remuneration when records are played by radio and television or otherwise communicated to the public. This is opposed by broadcasting organisations. The Rome Convention also obliged signatories to apply the conditions of the Berne and Universal Conventions to sound recordings.

A second Convention signed in Geneva is 1971 established a framework within which those Member States who were opposed to the equitable remuneration clause could nevertheless subscribe to measures against piracy.

Broadcast material is protected under the 1960 European Agreement on the Protection of Television Broadcasts. Not all Member States are signatories. As no definition of broadcasting is given it is assumed that it covers wireless transmission. It appears therefore not to cover material distributed exclusively via cable.

This brief review of copyright shows that a number of different conventions cover the various elements of a multimedia product - sound, text, and images. In the case of sound and cable distribution copyright protection is insecure. Even for film and video Member States assign copyright ownership to different parties of the production process. For example in France copyright of a film rests with a producer, whereas in Denmark copyright rests with all who make an artistic contribution unless a contractual agreement has established otherwise.

The distribution of learning material in a multimedia format is inhibited first of all by national variations in the application of Copyright Conventions but also by the inadequacy of the Conventions themselves. The Conventions offer only limited protection to a sound, text and image based product, which by its nature is a collaborative affair and contains elements which are now covered by different laws.

An additional problem arises once a product has been distributed by electronic means. Today's technology allows complex multimedia products to be distributed via satellite or cable and to be copied - either in the home, in schools or at work.

Such copying would in effect constitute piracy under the Berne Convention in so far as an author had not given permission for a product to be reproduced. However the very ownership of home copying equipment presupposes its use or potentially illegal means. The 1967 revision of the Berne Convention therefore includes an exception clause:

"It shall be no matter for legislation in the countries of the Union to permit the reproduction of such works in certain special cases, provided that such reproduction does not conflict with a normal exploitation of the work and does not unreasonably prejudice the legitimate interests of the author".

Such a broad treatment of the problem has lead to widely varying interpretations in the Member States. Home copying is of course important to the development of the market for training and educational products. Currently legislation in the Member States operates either against home copying or in favour of home copying with a levy system to provide for remuneration. Not surprisingly levy arrangements vary between the Member States.

5.1.2.3. Computer Software and Compatibility

Intellectual Copyright

The issue of compatibility - sometimes referred to as interoperability - is a major cost issue for the training and educational domain. Training and educational institutions typically have to operate within restricted budgets and cannot afford the long term effects of purchasing incompatible systems and software.

Interoperability is a prerequisite for the developing European training market.

As in other areas however the desirability of access to materials has to be balanced against the intellectual rights of producers.

Computer software especially designed for the training and educational market is as vulnerable as multimedia products are to copyright abuse. Loss due to software piracy, for all sectors, was calculated at 240MECU for the United Kingdom alone in 1986.

However a significant difference between computer software and other multimedia products is noted in the Green Paper. Copyright in certain areas of software production can actually confer de facto monopoly rights as is the case with proprietary operating software because the interface component - the access protocols which reside between the applications programme and the operating system - is proprietary and attempts are made to protect it under copyright laws.

The Green Paper states:

"The development of compatible programs, which is desirable from the point of view of both competition and industrial policy, would be impeded if competitors were prevented from incorporating into their product range protocols or interfaces that are gaining wide support as likely international standards. The same would apply if protocols were technically available, but only a licence fee that only the largest competitors could afford".

For this reason the specific exclusion of protocols and interfaces from copyright and similar protection is now an issue.

Electronic Accounting.

Another important area in computer software copyright is the electronic control and accounting of the remote of copyright software and other resources. Sophisticated accounting procedures have already been developed in the area of musical copyright, whereby in States which are signatories to the Rome Convention performance of copyright music can lead to a revenue being paid to the copyright holder.

Such a system could be applied to the educational use of software. This issue is now being pursued under the Call for Proposals for ESPRIT II.

Telecommunications Services.

The development of advanced telecommunications services relevant to training and education, such as videotext and photovideotext conferencing, videotelephony and broadband services, are ostensibly market demand issues. However, the educational market is one in which demand is almost inevitably latent. The budgets of educational users are too restricted to expect that the majority of training applications will emerge in the early days of a new technique or new services. Further liberation of the market for value added services, and changes in the regulations which prevent value added services being provided over cable TV networks could, by extending the range of suppliers, create conditions in which the long term value of the training and educational market is recognised.

At present, the needs of the training and educational community take a low priority. It is also quite likely that the provision of high quality services to the home - such as ISDN - will take a low priority in the infrastructure investment plans of the national TAs.

At present ISDN is available on an experimental basis to the business market. Video telephony, which could be used for face to face contact in tutorial sessions, is virtually non-existent in Europe. Videotext on a significant scale is restricted to France, yet videotext could provide a useful medium through which image related training databases could be established and interrogated. Photovideotext, planned as part of Japan's INS service, is a low priority in Europe but again in special training situations could be a valuable source of economies - for example in joint authoring. Video conferencing is restricted to a small number of public studios (only 22 in France) and some private studios. Interactive narrowband and broadband services are restricted to experimental situations. The potential interactivity to provide "on-demand" training services has not yet been addressed in the communication environment.

Broadcasting Regulation.

In 1981 there were no satellite television services in Western Europe. By 1988 over thirty satellite television channels were available via the Intelsat, Eutelsat and Telecom satellites. In 1989 the first programmes were broadcast from the 16 channel ASTRA satellite.

It has been estimated that by 1996 there could be as many as 208 satellite transponders available for TV transmissions and that by then as many as 45 million European homes will be receiving cable network.

Under national legislation every Member State without exception imposes an obligation on broadcasters to provide some form of educational programming. New satellite television services however, for the most part, do not fall under national broadcast regulations. A variety of agreements have not been made between Member States and satellite broadcasters on the content of programmes and on the origin of programmes within schedules. This latter point is the main thrust of the EC Directive "Television without Frontiers".

The result of the expansion of television broadcasting, and the limited range of new EC regulations, is that the obligations to educate and inform have not been transferred from the national to the transnational environment. Television across frontiers is one of the best media for providing much needed "European training and Education". Although the facility exists the legal obligation does not.

5.1.3. Requirements and Options

5.1.3.1. Copyright Legislation

The multimedia environment would benefit from clarification of and harmonisation of existing copyright laws.

In particular it is important to address the circumstances which arise when multimedia goods are produced. Multimedia presents an even bigger challenge to copyright laws than the existing treaties have had to address.

Interoperability is crucial to the future of cost effective training.

Multimedia and interoperability are key issues. The voice of the training and educational domain may not be strong enough to alter or shape the outcome of existing discussions but it should be able to add its voice to chose of other users.

Whilst copyright protection is vital to ensure that new multimedia products reach the market, it is vital also that copyright legislation does not confer monopoly rights on any supplier. It would benefit the training and education and domain if interface software was not protected.

Accounting:

A system which allowed electronic accounting of the remote use of computer software and other multimedia resources would assist the development of cost effective joint authoring systems. The issue is being taken up in ESPRIT II.

5.1.3.2. Telecommunications Services

The training and educational community is not capable of engaging the most advanced technologies on a sufficient scale because of budget restrictions. However the training and educational market is significant in the long term. Certain areas of specialised academic activity can budget for advanced IT+T equipment and services. For the most part however, training and education is a follower of wider trends.

The uptake of any new service or technology relies on pioneer users prepared to pay a premium price for the privilege of attaining'computerised advantage' over rivals. As the price of a product or service falls, wider demand is created and this, in turn, stimulates further price reductions and even wider demand. This typical supply and demand curve of innovative products is critical in determining the point at which training and educational organisations are able to take advantage of new technologies.

It is important for the long term development of training services that training suppliers enter the innovation curve at the earliest possible point. One way of ensuring this is to provide discounts for educational use of telecommunication services.

Another method may be to widen the range of supplier organisations. A broader range of suppliers ought to create conditions in which suppliers of services compete for the costume of trainers and educationalists, and help reduce costs thereby bringing them earlier into the realm of advanced technologies.

This is particularly important for the future market for training services. At present the home market could be served either via the PTA's public switched networks, or in some Member States by the Cable Television franchise holder. Unfortunately the legal conditions governing value added services via the cable TV network vary from country to country.

Two different sets of arrangements, in the United Kingdom and the Netherlands, illustrate the potential scope for legislation.

In the United Kingdom cable television franchise holders can both produce and supply television programmes, and can apply for a telecommunications licence which allows them to provide value added services. A new media law proposes to make cable franchise holders responsible only for infrastructure development in their particular area. Cable franchise holders would not be allowed to produce or disseminate their own services. Their profitability would depend on providing high quality infrastructure and stimulating its use for a range of services in competition with British Telecom.

In the Netherlands, cable companies are not allowed to provide value added services. In recognition of the importance of new telecommunications services, the Amsterdam City Council is now considering how to make better use of its cable resource. The most probable line of development is that the PTA and the cable company establish a joint venture to market value added services via the cable network.

In return the long term provision of cable television will remain the cable companies prerogative.

Either one of these scenarios could lead to the exploitation of existing infrastructure and in the process help to expand the market for educational services.

5.1.3.3. Broadcasting

Regulations which impose an obligation to educate and inform are already accepted practice in all Member States. It is important that this principle is extended into the European dimension.

It would be possible to impose an educational on transnational service but a more appropriate mechanism in the satellite environment would be to establish a training and educational channel for Europe.

5.2. NORMS AND STANDARDS IN ALT

5.2.1. Statement of the Issue

Learning technology components must be integrated in a standardised context which guarantees interoperability and enhances market penetration. Market integration, technical integration and harmonisation is only possible through the identification of appropriate interoperable standards. They are a pre-requisite for an effective and economic open learning market. Without endorsed standards, markets are unlikely to develop. Potential users are wary of investing in equipment that will soon become obsolete and manufacturers are wary of producing products that nobody wishes to buy. Standards bodies (like the International Organisation for standardisation - ISO; Consultative Committee on telegraphy and telephony - CCITT; CEN/CENELEC; etc) and much of the Commission work in IT/telecommunications area often encourage standardisation activities in order to stimulate markets and reduce risks to suppliers and users.

Basically, standards can emerge either by dictate or by consensus and in both IT and telecommunications we are moving from the first situation to the second.

Standardisation should be both technology and market driven and assist European industrial and commercial organisations to improve their economic performance through the use of Advanced Learning technologies.

Central to the learning and training market is the user with his/her specific learning and training needs, whether the user be an individual learner, a training purchaser, a training deliverer or a courseware author. Users must be involved in the process of defining a learning infrastructure in order that maximum benefits are derived for both the demand and supply sides of the market.

This task is made more difficult than it already is by the embryonic state of the ALT market itself which seems confused by:

- the absence of a clear understanding of the potential of Learning technology for training within organisations
- the failure on the part of many ALT users to place it within a broader strategic training framework

5.2.2. Description, Status and Trends

Nowadays no specific standards for educational technology exist, but some major trends on the market can be identified. In the related domains of information and telecommunication technologies, more standards have been identified and several moves towards harmonisation were undertaken on the European scene.

A list of technical standards, conventions and possible trends on the market have already been described in para 5.1. of this document.

Interoperability and standardisation of technologies is one of the major topics of the Exploratory phase of the DELTA programme. The work done within Action Line IV concerning interoperability and standards in ALT represents the state of the art and future trends in this domain. DELTA projects as OSIRIS, LEAST and SAFE critically examine possible standards for an open learning environment in Europe, and make positive recommendations on future standards like :

- interfacing and communications protocols for telecommunication applications in education
- recommendations on common/standardised user interfaces and presentation models
- identification of common/standardised systems architecture for authoring and learning environments
- recommendations on common/standardised design methodologies and protocols supporting the transfer of learning materials
- identification of criteria for quality assessment of learning materials and learning environments

The various ALT environments will be related to the OSI standards. In identifying market related standards in the field of ALT, the DELTA projects aim to help large industrial and commercial organisations in Europe improve their competitive positions through the application of Advanced Learning Technology (ALT) in their Human Resource Development (HRD) activities.

OSIRIS (Optimum Standards for successful Market Integration of Multimedia On-line services) is a strategic study which will examine technical standards and human competence in relation to ALT in real market situations. OSIRIS uses a two phase approach. In phase one, OSIRIS gathers an extensive knowledge of Open and Distant Learning by studying the current environment of ALT covering technical, sociological, psychological and economical factors, and by studying the current situation in training in a significant number of European companies. Phase one concludes with the construction of a Model of Effective learning in order to generate statements of hypothetical standards. Phase two will validate these standards by testing them, training users and providers in industry and commerce. These standards will drive the development of ideal/typical functional and technical specifications for ALT. Recommendations for a cost-effective learning system and organisation with practical aims will then be drawn-up.

The overall objective of the **LEAST** project (LEArning systems STandardization) is to produce recommendations and proposals for the selection of standards, on top of existing and emerging technology standards, for the representation and exchange of informations between the different learning sub-systems.

In that framework, the three main technological areas of concern of that project are:

- selection of standards for the representation and exchange of multimedia information both of basic information (such as graphic, image, sound, video sequences, etc) and for structured information (such as courseware, script, etc);
- recommendations on adaptive and general applicable user interfaces;
- selection of standards for telecommunication protocols for the exchange of applications.

The project **SAFE** (D1014 - Standard Authoring Facility Environment) is working on the first steps towards standardisation of facilities and datastructures and to the definition of how state-of-the-art Information Technology and Instructional Technology can be merged to develop sophisticated authoring facilities. The main results will be the definition of an Open System for Instructional Development (OS-ID) with functional designs of authoring facilities embedded in it.

Emerging standards in the area of multimedia technology (notably CD-I and CD-ROM/XA) and engineering environments (as addressed by the ESPRIT project Atmosphere) are taken into account, while input will be made into standardisation of authoring environments, whether hypermedia or simulation-based.

Key issues in those DELTA projects dealing with standards are:

- The willingness of organisations in different parts of Europe to invest in ALT at the same rate and to the same scale (the standardisation of the market).
- Current practices and prospects for integrated standardisation (interoperability) at the European level in technical infrastructure, ALT environment, learner and tutor competence and organisational adaptability.
- The prospects for standardisation and interoperability of ALT design tools to enable flexible interface construction, accommodating varied training environments and needs. Recommendations on additive, generally applicable user interfaces and presentation models will be made.
- The best combinations of academic specialisations to design ALT solutions. The co-ordination of organisations in the goods and services sectors involved in the design, production and exploitation of training systems based on advanced components. Recommendations on standardised design methods and protocols supporting transfer of learning materials.
- Critical definition of standards for Open Learning. Identification of criteria for qualitative assessment of learning materials and learning environments.
- Proposals for standards
- Adoption of the standards by the Learning and training community.

5.2.3. Requirements and Options

The availability of appropriate technologies is not the restraining factor in the implementation of ALT. Rather, costs, the lack of standardisation to any meaningful level, and inappropriate pedagogic conceptions all exert major restraining influences.

Technical standards and human competence must be examined in relation to advanced learning technology in real market situations.

The success of advanced learning technologies will be determined by the correct market integration of a learning and training strategy which recognises the needs of the learner not primarily in terms of technological realisation and peripheral ergonomics but rather as complex sets of human, social, economic and technological requirements. The interoperability environment (for learners) exists at the junction of sociology, economy, market, psychology and technology. It is through the interaction of these domains that interoperability environments gain their characteristics.

Standards are usually developed with no involvement of users To achieve the goal of defining standards from the user point of view representatives of a wide spectrum of sectors must be involved in the research.

An important aspect is the willingness of the 'field' to use the suggested standards. If you want 'to develop a strategy to lead the market as a whole in the desired direction' the most important starting point is the usability of the standards to the leading companies and small and medium sized enterprises in that market.

The exploratory and main phases of DELTA must attempt to create sufficient mass in the market for ALT standards to gather their own momentum. So that any manufacturer coming forward with new products has to ensure that accepted standards for the user interface and the hardware interface for telecommunications purposes are met.

Standards and conventions in the domain of advanced learning technologies are virtually non-existent. Therefore more initiatives must be undertaken to identify and define standards on :

- criteria for quality assessment of learning materials and learner environment
- common and standardised system architecture of learning environments. Standards on learner workstations in the home, dedicated or distant environments are a major concern
- common and standardised systems architecture for authoring environments
- development of portable ALT software in a multi-OS marketplace
- access to information resources
- interfacing databases
- standardised design methodologies and protocols supporting the transfer of learning materials
- document protocols
- interfacing and communication protocols for telecommunications applications for example to handle images interactively
- adaptive and general user interfaces and presentation models for an optimal man-machine interaction

6. IMPLEMENTATION: TRANSITION AND EVOLUTION

6.1. THE EDITORIAL SCENARIO

6.1.1. Statement of the Issue

Most distance or remote learning is still largely based on traditional printed materials. However, there is an increased demand and concern for new products, once the compatibility problems are solved.

In the future, users of learning materials, such as corporate training managers or university training services, will 'remotely' consult descriptions of learning materials. Expert resource centres will remotely 'serve' information and educational materials on different topics, eg medical images, electronics, new materials, etc. Users will download electronic versions of the bibliographies or the draft texts they are interested in. Corporations or teaching institutions will have the materials tested by their students and will improve them locally through their desktop publishing services. They will remotely access demonstrations of available videos and educational software packages.

According to the distribution mode chosen by the provider, the users will either download or order the products they want in order to set up their own multimedia library and personalised catalogue of products. Such libraries could be set up in local resource centres serving the local community by providing easy access for the community to a customised information resource of relevant teaching material. For the inhabitants in the area, who do not wish to browse through the material in the library, dial-in services for the database services and local delivery services will be established for the electronic educational materials, and a rental service for books and videos.

This scenario allows us to highlight a series of issues.

- Who will decide upon technical and content-related requirements?
- Who will participate in the design of those products?
- Who will produce them?
- Who will sell or disseminate the services and packages?
- Which actors are, willingly or not, working in such a direction?
- What are conditions are necessary for this to be a realistic option?

6.1.2. Description, Status and Trends

The diversity of actors in Europe does not favour a coherent strategy for market development in those new products.

Compared with the American market where big companies, such as Mac Graw Hill in the publishing arena or Microsoft and Lotus in the software arena, are able to invest and challenge on a large educational market, the European market looks shy, uninviting and extremely fragmented.

Traditional publishers and new providers are exploring the market potential of new products such as:

- **databases**, e.g. catalogues of interactive video and educational courseware, data bases of training centres, public domain courseware catalogues, databases of drills, practices and tests in several disciplines,

- electronic books, stacks (in Hypercard stacks are cards or units of information organised logically),
- educational software packages,
- teleloading of desk-top published materials,
- updating of learning materials through telecommunication networks,
- delivery of additional materials,
- distant ordering and payment of courseware or other materials.

These new products will eventually be attractive to the national publishers and providers of services for education and training. However, the national markets are not broad enough to build strategies in those areas. There are still many uncertainties in the area of technical standards to grapple with. There are not captive markets as was the case with textbooks in some European countries. Translation into several languages must be easy to implement on products.

Moreover, there is a diversity of producers who have a limited capacity to invest money. In the arena of multimedia materials production, for example, we may find:
- authors,
- traditional publishers,
- specialised publishers,
- software producers (software houses),
- research centres,
- traditional training centres,
- in house training centres,
- distance training centres.

There are variations in the degree of involvement of producers in the different phases of production:
- design,
- implementation,
- publishing and diffusion,
- customer support.

There are several possible market choices, on a European scale. For example, there can be versions of products on networks as well as versions on paper and on CD/rom. Choice of media will depend upon marketing strategies. Versions in CD/rom will eventually be more attractive for publishers in so far as it is more similar to traditional products. The main concerns about network developments relate to the fact that tariffing is difficult, viz dealing with a number of small clients, protection against piracy is far from being solved etc. Many potential providers still prefer physical packages which can be found on a bookshop's shelves.

In the case of courseware, choice between the alternatives, network versions of products and packages, is more related to copyright and piracy issues.

Teleloading can serve educational and training purposes. One user can consult a products catalogue, get a demonstration of all courseware materials and then download the material itself. For example, such a service was provided in United States for games. A company, Games Network, has sold software on cable networks. Subscribers, who had to rent a dedicated terminal on which the software was downloaded, were offered a subscription for a catalogue of 20 new games every month. The main difficulty for such a scenario lies in the pirating risks, and then, instead of downloading the courseware, the solution is to order and receive by mail or through appropriate dealers such as the video clubs.

Courseware packaging raises other problems, such as the choice of dealers (see in this chapter, the section on distribution), the quality of disk duplication, the tarification of this product compared with printed materials and the protection aspect. The more interactive a product is, the more expensive it will be, although this does not necessarily imply that it will be used for a long time by a learner. If it is learning effective, it will have a short lifetime.

Desk top publishing is another interesting option for education and training, and it mainly addresses the issue of resources and documentation, in particular the creation of centres of excellence for providing specific learning materials. Remote access to resource centres would allow educational or training centres to produce slides, booklets, textbooks on any topic dealt with by those centres. For example, some institutes collect multimedia resources on the brain or on heart diseases. These could be accessed and adapted by authors of course materials, by tutors as supplementary material and in some cases directly by students as examples.

Several experiments have been carried out in exchanging and adapting learning materials from one country to another. With the development of desk top publishing, this kind of transfer is no longer exclusive to the traditional publishers. It becomes possible for institutional users of learning materials to transfer some of their in-house products. For example, the European Social Fund has funded the translation of a set of learning materials for teaching electronics. Those materials have been translated from German to English, adapted to the UK environment where they had to be used, and technically transferred from a MS/DOS environment to a Macintosh environment.

Regarding those fields of potential applications - databases (CD products or networks), courseware downloading and packaging, desk top publishing - the extension of such experiments to a broad European scale and the choice of common strategies require strong support from the public sector in pump-priming such developments. The traditional publishing industry is reluctant to base its developments on unstable technical standards, and most of the interested parties do not get the critical mass necessary to invest in common technical development tools ensuring **interoperability**.

Many of these developments may come from institutional users of learning materials such as open universities, in-training services of large companies, etc, but it will be difficult for them to establish a commercial significative infrastructure. They are not willing to put the money to build on a European basis.

6.1.3. Requirements and Options

Given the number of actors and operations involved in the editorial scenario, the requirements for realising the scenario are more or less the full set of requirements set out in part 5 of this document, especially regarding specifications for configurations of workstations, communication standards and standards for courseware production, information storage and retrieval.

The specific requirements for the editorial scenario are focussed on product-oriented developments.

1. There is a need for a standard lay out for courseware catalogues, as well as for storage and retrieval methodologies. It would require research on the existing products in Europe, standards and the necessity for indexing.

Such a catalogue could be specified for the requirements of the learners and trainers in eventually providing information on evaluations as well as information on available products. It should be commercially orientated but set up by a consortium able to guarantee neutrality towards the different interests.

2. There is a need to define a European policy for production of high standard courseware. Only if Europe reaches an agreement on standards will it be possible to obtain the necessary critical mass to allow large scale private production for the educational market.

3. A very critical area is copyright and protection of fiscal interests. Research and development needs to be carried out into distribution systems which guarantee maximum security for illegal copying and for fiscal transactions, thereby facilitating the transfer of course materials.

4. There is a need for research in methodologies for distribution of courseware, which typically comprises large and complex multi-media datastructures.

5. Public domain courseware will have to be developed in the fields of European interest. Courses on Europe as such as well as on specific topics influencing the life of all of the inhabitants of the Community, eg. the European regulations following the single market in 1993. Such courseware could be linked with access to the databases which will be established following the single market. Courses on how to keep updated with the European regulations in the different fields following the single market needs to be developed as well as courses on how to access relevant information.

6. There is a need to develop mechanisms for cross-cultural dissemination of information on good practice for production of courseware materials as well as for setting up successful distribution systems as an accompanying measure.

6.2 TECHNOLOGICAL SCENARIOS

All previous attempts to develop equipment for the sole use of education have failed. Although the education market is a fairly big one, it is also very price sensitive. The present and the future education workstation will be solely based on 'off the shelf products'. Any valid scenario should concentrate on technologies that are likely to generate consumer products.

The focus will be put on the technologies that are going to influence the development of new advanced learning systems in the future:

- the operating systems, a basic concern to any IT based product,
- storage devices, because of the availability of new means of storage and distribution, learning material will have a long term impact on the overall scenario of ALT products.

More specific issues concerning authoring workstations user interfaces, and other learning facilities have already been described in section 4 (learning technology).

6.2.1. Operating Systems

6.2.1.1. Statement of the Issue

Operating systems are the most stable part of the telematic environment and no major changes are expected in the near future. The current trend in favour of the non-proprietary systems will continue.

6.2.1.2. Description, Status and Trends

It is becoming clear that a full function distance learning application requires a multi-tasking operating system. At the moment 4 major OS are well established on the market: MS-DOS, OS/2, Mac-OS, UNIX considering the trend toward more standardisation, it is unlikely that OS like PICK, TRON and proprietary systems like VMS VM will play a major role.

There are about 20 million PCs running MS-DOS today. The fast growing performance of the workstations requires a high function high performance COMPATIBLE operating system. OS/2 is seem by most industry observers as the natural replacement for PC-DOS but an interim solution could be the use of WINDOWS, which offers a graphic interface to the DOS user.

UNIX, although still tied to its complex, programmer orientated roots, has made great strides in recent months in becoming easier to use and to install. UNIX's high functionality continues to be a major selling point in the industry. Although in some ways they are quite different, in many ways UNIX and OS/2 address the same market. In general, OS/2's strength is its end user orientation, packaging, and ease of use. UNIX's strength lies in its power, functionality and connectivity. The following table summarises the key features.

Comparison of the main features of OS/2 and UNIX

OS/2	UNIX
End User Oriented	Technical applications oriented
Simple packaging/ Maintenance	Complex configuration
Standard database	Multiple Choice for DB
Horizontal applications oriented	Vertical applications oriented
Selected industry standard available	Most industry standards available
Medium Connectivity	High Connectivity
Single user Interface	Multiple User interface
Real time support	Round robin scheduling

6.2.1.3. Requirements and Options

The production machine in the Training environment is likely to be UNIX based. The requirements in functionality and connectivity can only be met by UNIX. The target machines should encompass the 4 major OS' : UNIX, MS-DOS with WINDOWS, Mac-OS, OS/2 with Presentation Manager.

6.2.2. Storage: Educational Requirements and Technical Trends

6.2.2.1. Statement of the Issue

Developments in storage technology have resulted in an improvement of capacity, access speed and multi media capabilities. These developments will have great impact on learning technologies and learning applications due to improved performance, decrease in price and multi media capabilities.

6.2.2.2. Description, Status and Trends

At the moment two major storage technologies are well established in the market: magnetic and optical storage. Both approaches have their specific advantages.

Magnetic storage offers low access time, read/write capabilities and low price. Storage capacity is increasing substantially over the years.

Optical media on the other hand offers high storage capacity, multi media capabilities and are not as vulnerable as magnetic storage devices. A wide range of optical media is coming available on the market, varying from analogue to digital, from ROM to read/write many times.

Magnetic and Optical Storage Devices

	Digital Disc		CD-ROM (also WORM)	Magneto Optical	Tape		Card	Mag. floppy	Hard disc
	video	opto			magn.	opto			
SIZE (inch)	14/12	14/12	4 3/4 (120 mm)	5 1/4		12 inch diameter			
DATA STORED									
pictures	x	x	x	x				x	x
video	x								
sound	x		x		x				
text	x	x						x	x
data	x	x	x	x	x	x	x	x	x
CODING D=digital A=analogue	A/D	D	D	D	D	D	D	D	D
LIFE TIME years	up to 30	>30	10 to 30	>10	2	10	10	10	10
ACCESS direct; sequential	direct	direct	direct	direct	sequential		direct	direct	direct
CAPACITY byte/disc M=mega G=giga T=teta	>6 G		600 M	300 to 500 M (per side)	2 - 5 G	1 T	1 M	2 - 10 M	500 m to 1G
DATA E=erasable NE=non erasable	NE			E	E	NE	E or NE	E	E
WRITE/READ SPEED	up to 1 MB/S		2 to 8 M B/S	600 K B/S	0,1 - 1 M B/S	3 M B/S	120 K B/S		1,5 - 3 MB/S

Despite the differences in capabilities, magnetic and optical storage will remain in existence next to each other. Related to flexible and distance learning are several issues on storage;

High Storage Capacities

Learning applications in general require large storage. Although hard disks as such offer high storage capabilities, they are not exchangeable. Optical media on the other hand are easily exchangeable and offer high capacity storage.

Multimedia Capabilities

One of the requirements for many learning applications is multimedia, including high quality sound and (moving) images. Analogue storage such as video disc and tape provide full multi media capabilities. However several drawbacks exist, such as integrating analogue video signals with computer signals, video disc is non-writable and there are the high costs involved with production based on the configurations needed. Digital optical media such as CD-ROM XA and CD-I also offer multimedia capabilities. For CD-I full motion video has been announced, and this gives it the same media functionalities as DVI. CD-type media also have the disadvantage that they are write-once devices.

DVI and CD-I (plus CD-ROM XA) are at this moment the most promising approaches towards multimedia storage. Both are based on very sophisticated compression and decompression techniques for handling full motion video. At the moment Philips International is developing with MOTOROLA a dedicated chip for decompression. This chip is expected to become available in consumer configurations in 1992 in Europe. However at this stage video quality is still not clear, performance resembles super VHS. DVI technology is at the moment available offering full screen motion video (still resolution 1024x780, video 512x256). DVI is based on a chip board to be incorporated in MS-DOS machines. As such DVI is independent of the background storage and can handle optical storage devices (CD-ROM type, WORM, etc) as well as magnetic devices (hard disk).

Read/write Capabilities

Although ROM technology is well suited for large storage, -writable storage is required for education. Magnetic storage offers -writable storage. WORM and write/read optical discs offer -writable features. At this moment only the Next Machine incorporates a -writable optical disc. Because DVI is independent of the storage medium used, it provides a potential base for -writable systems (based on hard disks) suitable for motion video. DVI provides a board for recording motion video (256x128 full screen) with a standard camera, PC and hard disc. Performance is expected to improve over the next four years.

6.2.2.3. Requirements and Options

When defining requirements and options for learning, not only the technology as such, but also market issues should be considered. It is not expected that in the near future storage devices which combine high storage, full multi media and re-writable capabilities will be widely available. The only exception might be the NeXT computer, incorporating a magnetic optical re-writable disk, replacing the hard disk. However this system offers relatively low retrieval performance.

Making use of the compression and decompression techniques offered by DVI , in theory, magnetic storage could provide all storage functionalities, especially considering the progress achieved with storage capacity on hard disk. However hard disks are not easily exchangeable and are not suited for the distribution of multimedia learning applications.

As such optical storage technology is progressing very fast in terms of capacity and re-writable features (Eg. NeXT computer), but they are not likely to penetrate the educational market on short range due to high costs and lack of standardisation.

At this stage and in the near future only three storage devices are offering full multimedia features and providing high storage capacity.

Interactive video discs are based on a well established technology and provide (still) good functionalities for full interactive video applications. Costs involved with the hardware configurations will however limit its penetration in the educational market.

CD-I will enter the European market within 2 years, providing full motion video capabilities. CD-I is targeted at the consumer market, offering a integrated system at a acceptable price level. CD-I is downward compatible with CD-audio and is expected to be successful on the consumer market. However due to the fact that CD-I is basically a closed and integrated system it lacks flexibility.

DVI is an open ended system, available on the market at this moment, offering comparable multimedia capabilities. For educational application the recording facilities DVI is offering at a low price level ($2000)might be important. Furthermore DVI is MS-DOS oriented and it will, in all likelihood, be incorporated by MicroSoft as a standard for the new integrated MS-DOS/Windows release.

Overall CD-I and DVI offer equal functionalities (except for video recording), but are based on a different market strategy. CD-I will appeal to the consumer, due to the easy integration with home audio visual equipment, while DVI offers more flexibility and integration with business configurations appealing to professional applications.

For educational usage both technologies are considered relevant, but market penetration will define which technology will provide a basis for European wide production and distribution of learning materials.

6.2.3. References

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6.3. TELECOMMUNICATIONS SCENARIOS

6.3.1. Statement of Issue

Developments in the field of Telecommunications have resulted in an increasing improvement in terms of capacity of information transmittable from one point to another point, either as data, voice or picture.

The high performance tools will have a great impact on training applications, but the success of advanced telecommunications in training is not only a question of technology but it depends also on social, political and economic factors.

With the introduction of optical fibres and the development of fast switching, the cost of data transmission is now falling faster than the cost of data processing.

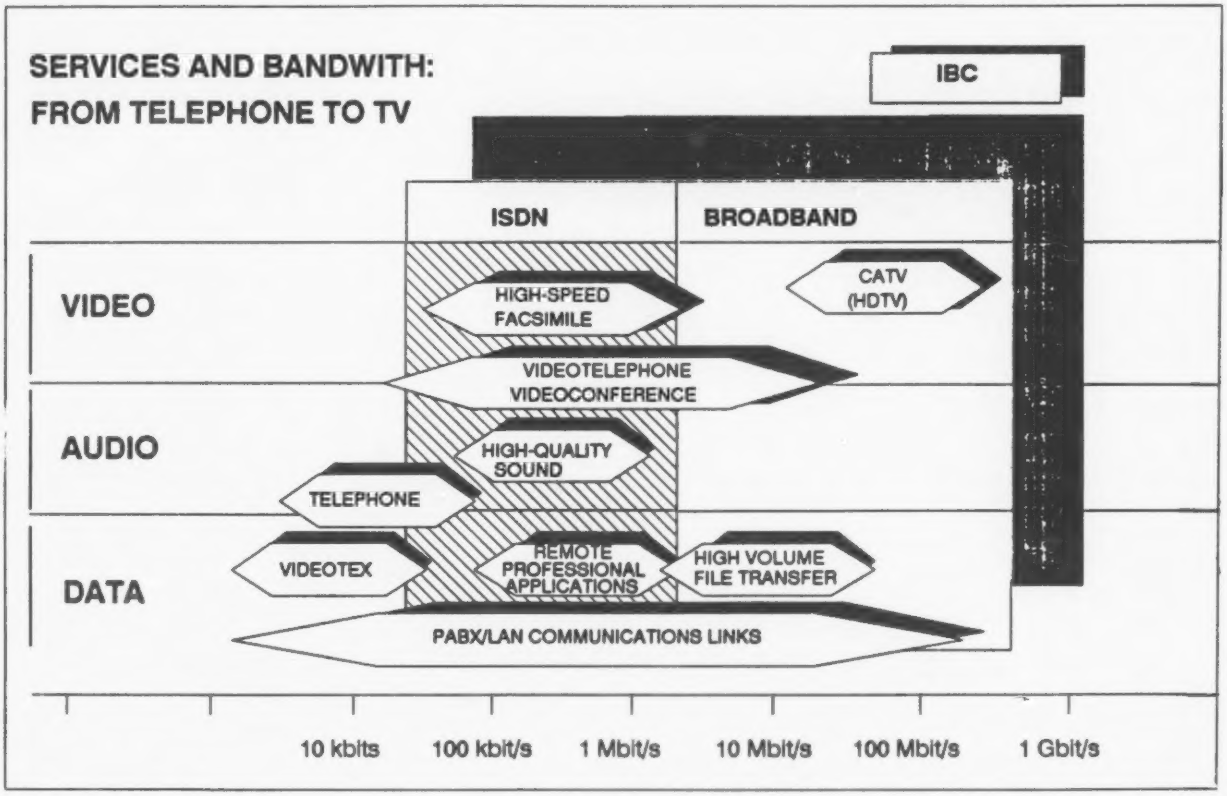
6.3.2. Description, Status and Trends

The introduction of the high width band in the network will make many services available for the first time, via the general switched telecommunications network, especially videocomunications. In fact, the transmission of high quality pictures requires, in general, transmission above 2 Mbits/s. The main issue will be the development of IBC which will allow a rate of 140 Mbits. This will be achieved through the use of optical fibre. Several localised developments are already underway for linking subscribers with optical fibre, but not all are compatible. This network will be the major infrastructure for the future and it will support learning applications as well as health care applications, administration (custom finance etc) manufacturing, transport, distribution and entertainment (HDTV, Videotext etc)

These integrated systems will remove most of the geographical and media obstacles from everyday personal business and training. As the need for retraining may become a major problem for Western Europe, the consumption of services (all domains) independent of the location of the consumer will have a very high value factor.

Standardisation of interfaces will go a long way towards ensuring compatibility. The objective must be the standardisation of the user-network interface especially in the training domain.

This shows the area of the ISDN and the full range of services available.


SERVICES AND BANDWITH:
FROM TELEPHONE TO TV
IBC
ISDN
BROADBAND
VIDEO
AUDIO
DATA
HIGH-SPEED FACSIMILE
CATV (HDTV)
VIDEOTELEPHONE VIDEOCONFERENCE
HIGH-QUALITY SOUND
TELEPHONE
VIDEOTEX
REMOTE PROFESSIONAL APPLICATIONS
HIGH VOLUME FILE TRANSFER
PABX/LAN COMMUNICATIONS LINKS
10 kbits
100 kbit/s
1 Mbit/s
10 Mbit/s
100 Mbit/s
1 Gbit/s

6.3.3. Requirements and Options

The introduction of computer intelligence into the telecommunications network will increase the convergence between telecommunications and data processing. The extension of the general telecommunications network into a network able to carry both narrow band and wide band services will bring the introduction of new categories of services.

The following paragraphs describe the likely future for the use of ISDN in the learning domain.

The Network

The transmission over the network will be over 64 Kbit/s to the normal subscriber. This mean that it will take only 3 to 10 seconds to transmit a still picture having a higher definition than a television screen and 1 minute to transfer the content of a 500 Kbytes diskette.

A typed page could be received, with laser quality, in 5 seconds.

With ISDN, speech text data and pictures are transmitted over a single telephone line, and the same jack can be used to connect a facsimile machine, a micro-computer, a videophone, a videotext equipment and a telephone.

Thanks to the separation of the information, transmitted in various channels, the user will be reached at all times even if he is busy with an another service.

Mainly through the work of the CEC regarding interoperability, will it be possible to interconnect the different national networks and trans-Community networks.

The following table gives the volume of access to ISDN (64 Kbit/s) in different countries (USA compare to 4 European countries) by the end of 1993.

COUNTRY	64 Kbit/s ACCESS
USA	1 500 000
France	150 000
RFA	200 000
Italy	30 000
UK	100 000

There is virtually no limit to the potential uses of ISDN, and it is probable that users will invent an unprecedented range of applications. There are already applications in learning sector. The examples given below are taken from the numerous applications derived from partnerships working in DELTA programme.

Distance Interactive Video Library Consultation.

The local user should have at his/her disposal a computer (Workstation) using a videotext interface and a picture interface. Broadcast reception hardware may also be of use for a feed back non interactive link with a satellite.

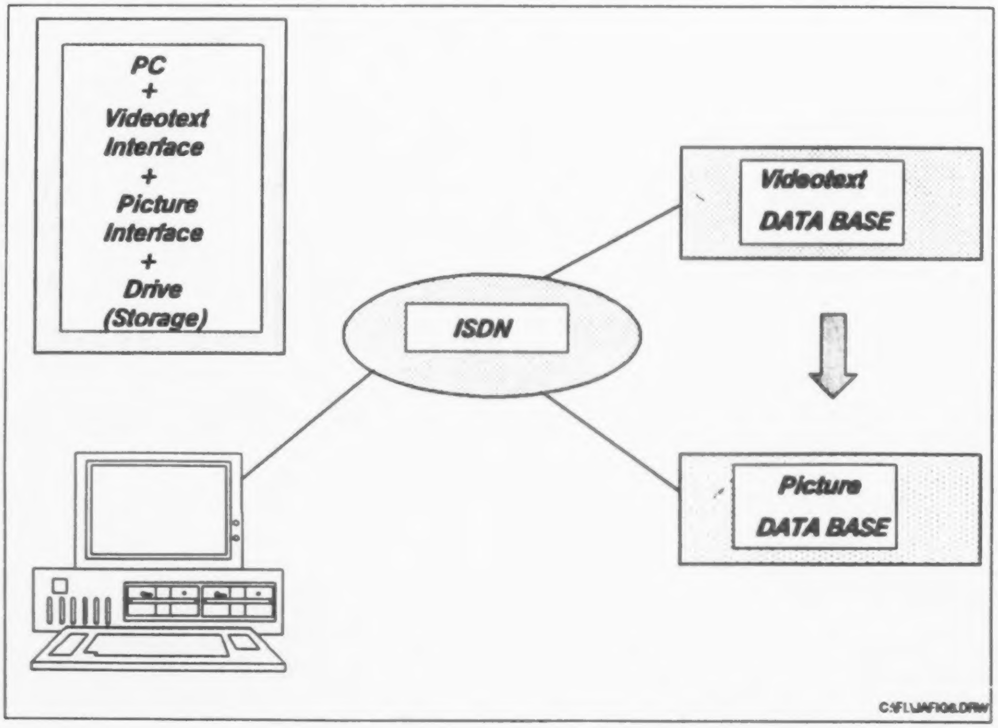
The program running on the local computer will help the user in selecting appropriate video material through the ISDN network. It will also provide didactic assistance, enabling the user to put the received material together and produce interactive video material of high quality. The local computer will be linked to the ISDN enabling contact with a central videotext data base.

The central videotext data base which will hold information about the available video material, will be linked to the ISDN network somewhere in Europe.

The distributed video library will contain interactive video material stored anywhere in Europe (Even in a different place to the videotext data base) and may be split by site. This material will cover all application domains. All information about what will be stored will be available in the central database.

The video material will be transmitted over the ISDN network to the user, or by using a satellite (Olympus for example).

Video consultation



6.4. INFRASTRUCTURES

6.4.1. Local Training Centres

6.4.1.1. Statement of the Issue

Local open access centres allowing public access to information and telecommunication facilities for training and education are considered central to the use of ALT.

Although education and training are increasingly individualised, there is a strong need, at a local/regional and/or national level, for places which will provide general non individualised training services and technical expertise.

6.4.1.2. Description, Status and Trends

Open and distance learning is unlike other forms of learning because the individual learners are isolated from each other. High dropout rates are common and whilst this means that the remainder are more highly motivated than their institutionally based counterparts the group dynamics found in the institutional setting do not operate. The provision of local study centres partly alleviate this isolation.

Beside its broadcast television programme, the Open University has developed a network of 250 local study centres which serve to distribute complementary materials to the 80,000 students it has each year.

In more targeted areas, such as training in technology, the Information Technology Centres schemes in the United Kingdom and Centres X2000 in France have demonstrated the public need for technically based training. Such centres may help to achieve increased use and appropriation of information and telecommunication technology for a significant part of the population.

If such local facilities do not exist and if technical infrastructure for training relies entirely on a healthy well equipped population, there is a risk of over-emphasising those segments of population. This is clear when looking at statistics on the uses of new technology, according to social segments of the population. In Europe, most home computer purchases rely on the top 20% of national average incomes (with the possible exception of BBC-equipped British households). That does not necessarily mean a better acceptance of computers within adult populations as most home-used computers are low-level. Videotex, which was supposed to make information access broader and more democratic, has proved costly and, moreover its main home users in France are limited to the higher social bracket.

When dealing with unemployed young people or unskilled workers, whose training needs are an important part of global training, there is a need for high level learning technology, which those categories of population cannot afford for home use. Television, which has become the most affordable medium in this context, is poorly interactive and could not provide an adequate intelligent knowledge-based unit for training.

Public or private open access to learning machines and facilities of use should then be investigated. Learning services, based on new technologies, could be evaluated and eventually priced, as in photocopying services.

6.4.1.3. Requirements and Options

It is necessary to establish mechanisms -which in some cases may be based on existing institutions - which may support the two-way interaction between development and implementation.

Four requirements can be forecast for centres:

1. **Access** to the equipment
New skills are required within such centres so that services can address different sectors of the public: adults as well as children; people from private and public sectors; workers from different sectors.

When dealing with access to databases, connection problems on networks, videotex consultation, specific **tariffing and security** of equipment must be considered.

Specific equipment, such as card-equipped public data terminals, could be tested and allow access to special services.

2. Provide **services**
A broad range of services must eventually be covered which would be based on the access to technical facilities and the information basis of each specific centre.

3. **Provide information** which would be transferred from European, national, or regional levels on:
- certification
- curricula
- training support
- existing courseware and demonstrations/descriptions locally available.

4. **Produce information**
This would depend of the specificity of the services covered by the centre. It could be targeted to training software evaluation, to a regional who's who, to human resources for implementation of learning technology or for training.

The format should comply with the recommendations of national resource centres. Each local unit, in its method of formatting and assembling information, will have to be interoperable with the network(s) in which it operates.

5. Organise **training** modules and provide **certification.**

These requirements imply **equipment specifications,** in terms of common and interoperable equipment, and transferability of the training modules which are developed in different regions of Europe.

Such centres should take into account **several dimensions**:
- regional and local requirements
- administrative level and certification
- sectoral specificities.

6.4.2. SETTING UP MOBILITY SCHEMES, RESEARCH NETWORKS AND CENTRES OF EXCELLENCE

6.4.2.1. Statement of the Issue

There is no point in running a major R&D programme, or indeed any applications programme, unless one considers the skills required to make this programme work successfully, on a European scale.

It is then essential:

1) to identify centres of excellence in specific areas of research in advanced learning technology,
2) to design, specify and launch networked activities which promote information exchanges and avoid duplication of efforts,
3) to support the exchange of staff members between those centres,
4) to encourage those centres in transferring their knowledge to other centres - through various means of information diffusion - and to organise training sessions for the outside world.

6.4.2.2. Description, Status and Trends

The development of a unified European provision of Advanced Learning Technology systems and resources, requires the concerted input of a large number of actors. To ensure effective collaboration at the European level and to avoid duplication of effort, networks of research and development activities need to be established. These facilities will support a wide range of workers, including those in academic and industrial settings, and individuals.

Several topics have been identified and explored during the DELTA exploratory phase, :
- the **pedagogical issues**: the requirements,
- the **market issues**: the strategic and economic importance of this sector, and the state of the art in terms of users and of available equipment,
- the **telecommunications**: the technology enabling "distance" learning,
- the **artificial intelligence** inputs: the technology enabling "open" learning,
- the **multimedia and hypermedia** developments: new ways of storing, accessing and presenting information,
- the **authoring environments**: the technology enabling the development of interactive software,
- the **cross-cultural dimensions**: the psycho-sociological implications of open and distance learning.

In each of these areas, a network of human resources and basis of information for information and training could be set up.

Each of these areas covers a number of topics, which constitute many areas for research and researchers' training. For example, within the authoring area, design constitutes a special area of interest and a field for exchange of experiences.

6.4.2.3. Options and Requirements

Ensuring the stability of human networks of researchers at a European level requires three sets of actions:

- setting up events seminars, conferences where people can meet each other,
- funding mobility schemes so that researchers can be conscious of cultural differences and markets specificities,
- organising stable communication links through audio, video, tele-conference systems, allowing regular discussions on specific topics. Each of these topics would be under the responsibility of a network animator who would feed the system with relevant information and stimuli.

Setting up these European Advanced Learning Technology networks would improve both the quality and efficiency of learning technology and infrastructures.

It should also accelerate transfers and dissemination of research results for all sector actors in the European Community.

6.4.3. AN INFRASTRUCTURE OF ADMINISTRATIVE FACILITIES FOR PERSONAL LEARNING SYSTEMS

6.4.3.1. Statement of the Issue

One of the main issues in distance learning is to allow the system to award accreditation and certification. This requires a minimum level of conventions and coordination in the facilities provided on the network.

In parallel with the technical facilities provided on networks, it has been recognised that there is a need for a network of administrative facilities and human support.

6.4.3.2. Description, Status and Trends

The European dimension of Advanced Learning Technology activity creates a need for standardisation of courses/students' certification procedures, administration of agreed policy decisions, experimentation and testing of access modes and rights, and of security schemes.

There has been little work done in this area save in projects such as EUROPACE. This edits catalogues of courses, and provides a regular flow of information through conferencing systems. It helps establish feedback links from the student to the teacher through 'telephone time slots' or through electronic mail.

The function of administration can also include guidance on curricula for trainers as well as for trainees.

6.4.3.3. Requirements and Options

In order to design, specify and implement a network of facilities for the administrative support of Advanced Learning Technology activities, the DELTA programme of R&D will be examining the following areas:

- analysis of perceived user needs in respect of administrative support and specification of a range of recommended administrative structures

- analysis of perceived user needs in respect of accreditation and specification and recommendation of a range of possible accreditation processes

- studies of existing systems of accreditation and award in distance education

- analysis of security and access requirements and specification of protocols for security and access.

6.4.4. DISTRIBUTION

6.4.4.1. Statement of the Issue

An adequate distribution network of learning materials is a major issue if the end-user is to have access to products.

Distribution has to deal with:

1) **information on products** and links between those products and the related curricula;

2) training and **support** of the clients of the commercial/public human/technical network;

3) **maintenance** of the products delivered through networks;

4) **private/public infrastructure** of learning materials delivery;

5) **technical infrastructure** for local delivery;

6) **pricing** or tariffing of broadcast services;

7) adequate **protection** to avoid service pirating through networks.

Human and technical networks supporting the physical delivery, teleloading or broadcast of learning material are key issues for European competitiveness.

6.4.4.2. Description, Status and Trends

There are different distribution networks which are now developing according to the home, professional and school markets.

1. **Selling of educational software for home computers** is not supported by an appropriate distribution infrastructure. Software is currently provided through microcomputer shops, mail delivery (mostly in the United States), specialised stores such as Computerland. This is not completely satisfactory because users cannot see the products before buying them. It is seen as very difficult to sell to the general public, students or pupils' parents. Bookstores are neither prepared nor trained to sell this kind of product. Big stores find it difficult to sell software without trained staff.

2. For the **school market**, there is direct selling to local authorities, schools and national Ministries of Education. For this market, part of the distribution goes through textbook publishers who expand their catalogue with new products. Few of them provide good descriptions of relationships between their products and the school curriculum, though it could help distribution. Most of the negotiations focus on conventions on licensing.

3. Distribution infrastructure for **training materials** does not exist. Most products are customized to the needs of one client. Only some generic products are available on the market: authoring systems which are sold by the personal computer manufacturers to provide their clients with extra facilities for training on a standard workstation, training packages for largely distributed professional software packages (Multiplan, DBase, OS', etc.). There are no sectoral user groups in Europe, though some companies could be interested in sharing products they have developed on electricity, communications, nuclear power, etc.

Broadcasting through satellite and cable networks may offer new opportunities of distribution in closed professional user groups. But such developments depend upon the ability to identify market segments, e.g. scarce fields of expertise which are of interest to many users. On-going experiments still demonstrate that there is local company resistance to a broad exchange of training materials when the latter are developed inside the company.

A push in favour of a distant delivery of courseware through electronic networks is balanced by the risks of piracy and copyright problems related to the use of electronic delivery. Databases of learning materials require more care, intelligent indexing and proper software descriptions, so users can find their way through a great diversity of products.

6.4.4.3. Requirements and Options

Good Electronic Catalogues

In the future, distant physical delivery and on-line delivery of learning materials could complement each other in efficient ways. On line services may focus on learning materials databases which will give to the users the flavour of what is in such or such product. Such electronic catalogues will involve more and more graphics. 'Dynabook' style is required so that the users can freely and easily navigate within information.

Ordering Services

Such on line services must be connected to teleshopping services. Users must be directly connected, either by telephone or electronic mail, to the ordering service of the publishers from which they may wish to buy. Additional information will then be available and publishers will download or mail products. Direct ordering through value added services is unlikely. In many cases, hosts provide information but not distant selling. As far as commercial information and services are concerned, some publishers prefer to keep the link with their clients.

Vending and Delivery Machines

Physical delivery should still form an important part of the market. Renting learning materials may be a good way for learning centres to test the products. They may evaluate learning materials and build their own catalogue. Risks are in facilitating piracy, but special tariffs can balance this risk. Renting services could be based on automatic delivery through card-equipped lockers. This kind of equipment is now developing rapidly for videotape rental.

6.5. EVOLUTIONARY STRATEGIES

6.5.1. Statement of the Issue

Networked training offers the long term possibility of significant cost savings for transnational training. The successful application of the technology depends on a long term commitment to network infrastructure services - advising on standards, protocols and equipment, technological evolution, tariffs etc.

The application of network technology to training and education has to be coordinated across the Member States. The successful adoption of the technology could lead to significant long term economies - for example by helping to create a European market for training services the cost of investment in courseware development can be amortised across larger student bodies than is currently possible. The process of coordinating these developments necessitates a long term commitment to networked training.

6.5.2. Requirements, Status and Trends

There are several major network training and education programmes in Europe. The colleges of the University of London, for example, are connected by fibre optic lines and are provided with videoconferencing suites, in order that colleges can share their specialist expertise. The Europace project transmits technical training programmes via satellite to Eurostep centres in different European countries. Over 300 educational establishments are involved in training experiments on the Olympus satellite.

Training and education via the telecommunications network is, however, in its early stages. Most distance learning is still text based. Joint authoring is moving towards a greater use of computer conferencing systems, but these are often on different e-mail systems. Evolution towards image based conferencing in this and other areas could be held back by the adoption of incompatible systems.

In the area of integrated networks (satellite to copper or fibre optic lines) there is a danger that a number of competing schemes may develop in parallel and that resources may be spread thinly over too many initiatives. This is particularly the case with technical resources.

The regular use of broadband communications via the telecommunications network for educational purposes and with good pedagogic results is both prohibitively expensive and, technologically, quite futuristic.

However the evolution towards broadband telecommunications is a general trend worldwide. It is not a matter of 'if' but 'when' interactive, image based, communications become more routine. Undoubtedly in the course of the next decade, broadband telecommunications for educational and training purposes will become a familiar part of the learning process. In principle this development ought to make distance learning more effective and more attractive to potential learners. It ought to allow industry and commerce access to the source of their knowledge, expertise and skills requirements.

At present perhaps the rationale for long term investment in infrastructure services for training and education is not sufficiently apparent. Changes in training demand however are creating a greater need for flexible training services. Many organisations need to access training services and skills as and when they need it. This is particularly the case with small and medium sized enterprises. SMEs need maximum flexibility.

The nature of training requirements is changing and these changes are gradually being recognised. In order to meet the changing needs, conventional views of how training should be provided have also to be changed. The idea of an electronic university, which has been raised within the DELTA programme, very much depends on this re-orientation of ideas.

The electronic university has been described as a set of support services to enable the training and educational community to adopt compatible network equipment and to experiment with new training techniques. It could also facilitate the evolution towards the use of advanced communications services in the mid to late 1990s.

Under the RACE programme many of the technical and economic barriers to widespread broadband communications are being developed.

The technical, regulatory, and tariff-related experience built up under RACE can be used to explore ways of developing electronic infrastructure services for training and education. There is, for example, the attempt by RACE projects to define the optimal technical infrastructure for Customer Premises Networks. This work could be adapted to provide advice and guidance to trainers, whether in the public or private sector, on how to establish networks which are cost efficient and open ended - i.e.evolutionary and not in danger of becoming obsolescent. Conversely it is possible that in the RACE applications programme, the electronic university could provide advice and guidance to corporations who wish to use existing networks for training and educational purposes.

A number of essential services could be offered in order to make the adoption of existing network technology cheaper and more readily accessible. Similarly, services could be offered which manage the evolution towards advanced communications networks.

6.5.3. Requirements and Options

- The concept of 'training' should become more flexible. In the future a system is needed which facilitates rapid 'access' to knowledge, expertise and new skills.
- Access to these requirements will need to be an integral part of an individual's job performance criteria. In other words a system, both an infrastructure of services and a philosophy, is needed which requires and permits continual human resource development. The system has to recognise that individuals' 'expertise' can no longer be regarded as a static achievement, especially in relation to new technology.
- A system, or infrastructure of services, has to allow individuals to access skills and knowledge-training services, regularly, whilst still performing their jobs. This implies that the relationship between industry and commerce and the training community has to be closer and more collaborative.

This concept of human resource development is far removed from the traditional view of education. Its problematic nature lies in both the sudden and increasing demand for new skills and renewable expertise and in the absence of an infrastructure of services which allows rapid access to these requirements. As yet the conventional educational structures are unable to supply the required services.

The proposal for a new services infrastructure - an electronic university which uses the telecommunications network to provide a new training and education environment - has been developed specifically to address this problem. The electronic university would be an open-ended infrastructure of services which could be designed to satisfy four basic interrelated requirements:

- to create conditions in which the demand for rapid 'access' to new skills and expertise can be satisfied
- to create an experimental environment in which trainers and educationalists can pilot new techniques, as the telecommunications infrastructure and learner technology evolve
- to enable the conventional educational system to offer training and education to adults in work
- to achieve these objectives in a cost effective manner by realising economies of scale

There are three important aspects of this development:

- The use of electronic networks for distributed courseware production. This is, as yet, a relatively underdeveloped use of electronic networking.
- Computer conferencing - allowing research workers to keep up to date and to disseminate information on a day-by-day basis rather than waiting for the long production cycles of paper based journals.
- The use of interactive electronic networks for distance training. At present these systems are mostly either e-mail based or are based on small area networks - London University's Livenet for example.

At this stage it appears that a concerted action to define requirements and an infrastructure services solution might prove to be a beneficial long term strategy for Europe. The following is a list of possible actions to take the idea forward:

1. Establish a consensus on requirements and specifications amongst users
2. Define possible structures for the implementation of an electronic university
3. Establish the range of services which an electronic university might offer. These could include:
    - a responsibility to negotiate favourable tariff structures for the educational use of networks, allowing more widespread networking and eventually building a critical mass of educational users
    - providing advice, built on experience within RACE, on Customer Premises Networks and to negotiate favourable installation rates
    - negotiate favourable terms for education related communications services
    - promote international collaboration and cross fertilisation of experience
    - provide a means of interconnecting existing distance learning services

- provide a means of access to expertise for industry and commerce
- promote standardisation of learning technology and systems
- provide a testbed for distance learning experiments in advanced communications
- develop a central computer host, or clearing house service, providing access to databases of training courseware
- encourage the development of image databases for courseware production
- manage the evolution towards advanced communications services using for example broadband telecommunications, infra-red LANs.

There are five key steps towards the realisation of such a project:

1. A requirements analysis - the partners to the project commission a techno-economic analysis of market requirements
2. Resource analysis - a complementary activity is undertaken. The resources available to meet the requirements are assessed
3. A set of alternative development scenarios provide a focus for debate.
4. A period of public concertation and consensus formation should follow
5. Finally, the actors involved should develop a full implementation plan which outlines sources of public and private funding; details the services to be offered and their cost structure; defines an organisational structure and role of the electronic university.

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